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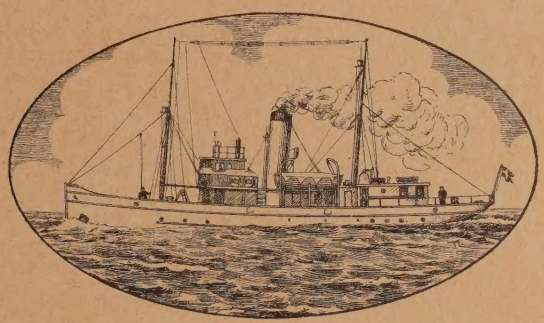
The Danish Biological Station

to

The Ministry of Shipping and Fisheries



XXXVIII.

1933.

By

H. Blegvad, Ph. D.
Director

Copenhagen. C. A. Reitzel.
1933.

The Reports from the Danish Biological Station (Nos. I—XXI) are published in the official Danish "Fiskeri-Beretning" for the years 1890—91 until 1912. After this year they appear as special publications. The Reports I—XXXII are edited by the late Dr. C. G. Joh. Petersen, the Reports XXXIII—XXXVI by Dr. A. C. Johansen and the Report XXXVII by Dr. H. Blegvad.

I. *C. G. Joh. Petersen:* Fiskenes biologiske Forhold i Holbæk Fjord. (1890—91)*) 63 pp. 1 Chart. Out of print.

II. *Idem:* On the Eggs and Breeding of our Gobiidæ. (1891—92.) 9 pp. Two Plates. Out of print.

III. *Idem:* The Pelagic Life in Fænø Sound etc. (1892—93.) 38 pp. Tables. Out of print.

IV. *Idem:* On the Biology of our Flat-fishes and on the decrease of our Flat-fish Fisheries. (1893—94.) 146 pp. 2 Plates. 1 Chart. Many Tables. Out of print.

V. *Idem:* The common Eel (*Anguilla vulgaris* T.) gets a Particular Breeding-dress before its Emigration to the Sea. (1894—95.) 35 pp. With 2 Plates.
Etc. 64 pp. Out of print.

VI. *Idem:* The Yearly Immigration of young Plaice into the Limfjord etc. (1895—96). 48 pp. 1 Chart. 2 Tables. Out of print.

VII. *Idem:* Plankton-Studies in the Limfjord. 1897. 23 pp. 1 Map. 4 Tables. Out of print.

VIII. *Idem:* An Otter-Seine for the Exploration of Deeper-Seas. 1898. 24 pp. With 10 Figures. Out of print.

IX. *Idem:* Trawlings in the Skager Rack and the Northern Cattegat in 1897 and 98. 1899. 56 pp. With one Map. Out of print.

X. *Idem:* List of the "Aalerusestader" in Denmark etc. — Smaller Communications. 1899 and 1900. 37 pp.

XI. *Idem:* I. The Biology of the Cod in the Danish Seas. II. On other Codfishes in our Seas. III. Some General Observations on Protection, Legislation etc. IV. Alterations and Improvements on Otter-seines for Zoological Purposes. 1900 and 1901. 44 pp.

XII. *Idem:* I. Where, and under what Conditions, can the Eggs of Plaice be developed into Young Fish within the Skaw? II. On the Young Stages of the genus *Zeugopterus.* (With one Plate). III. Can we enter into Competition with the Foreign Steam-trawlers in our Seas outside the Danish Territorial Limit. 1902 and 1903. 33 pp.

XIII. *A. Otterstrøm:* Eggs and Young of Fishes in the Danish Waters. (Investigations during 1904 and earlier years.) 1903 and 1904. 85 pp.

XIV. I. *C. G. Joh. Petersen:* The Influence of Light on the Migrations of the Eel. II. *K. I. Gemzøe:* Age and Rate of Growth of the Eel. 1906. 39 pp.

XV. *Idem:* I. First Report on the Oysters and Oyster Fisheries in the Lim Fjord. (70 pp.) 1908.

XVI. *C. H. Ostenfeld:* On the Ecology and Distribution of the Grass Wrack (*Zostera marina*) in Danish Waters. With 9 figures. 1908. 62 pp.

XVII. *C. G. Joh. Petersen:* II. Second Report on the Oyster and Oyster Fisheries in the Lim Fjord. 1908. (24 pp).

XVIII. *C. G. Joh. Petersen:* I. The Yield of the Limfjord fisheries in recent years and the transplantation of Plaice in 1908. With 6 tables and 1 Chart. II. Biological investigations on the stock of Plaice in the Limfjord. With 3 Tables. III. The Yield of the Prawn fishery from 1885—1907 and its improvement by means of protection. With 3 Tables. 25 pp. 1909.

XIX. *Idem:* Some Experiments on the Possibility of combating the harmful Animals of the Fisheries, especially the Whelks in the Limfjord. 20 pp. 1911.

XX. *C. G. Joh. Petersen* og *P. Boysen Jensen:* Valuation of the Sea. I. Animal Life of the Sea-Bottom, its food and quantity. With 6 Tables, 3 Charts and 6 Plates. 81 pp. 1911.

*) The figures in ( ) refer to the "Fiskeri-Beretning" for the years quoted.

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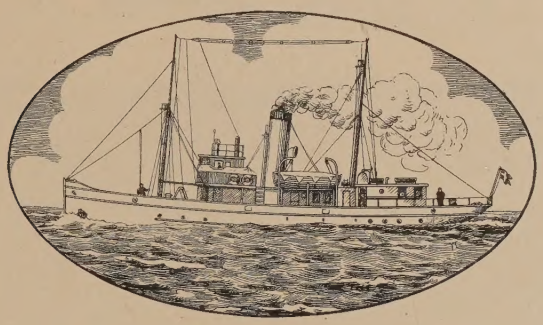

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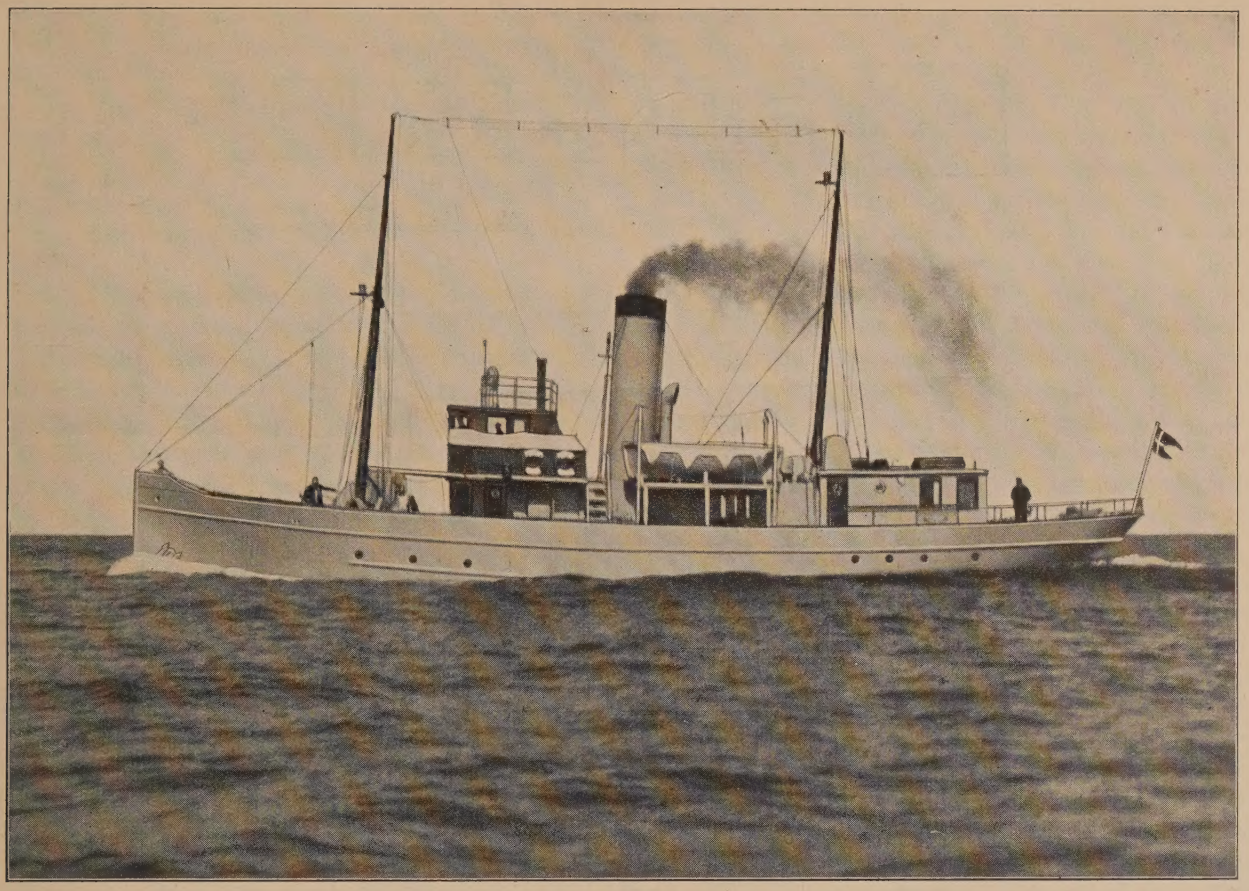

Fig. 1. "Biologen", the new steam-ship of the Biological Station.

H. BLEGVAD

S/S "Biologen".

The New Research Vessel of the Danish Biological Station.

In September 1932 "Japetus Steenstrup", the old steamer of the Biological Station, was replaced by a new one: the S/S "Biologen" (i. e. "The Biologist"). "Japetus Steenstrup" originally belonged to the State Railways and was taken over by the Biological Station in 1889; she was built in 1873, and was, by and by, rather out of date. She had a capacity of about 50 tons gross only; consequently she was not fit for use in the open sea but was chiefly built to ply the Limfjord. Nevertheless, this small steamer has given every satisfaction throughout a long series of years, and after several re-buildings and renewals — i. a. in 1918, when also the old name of "Sallingsund" was changed to "Japetus Steenstrup" — she was excellently fitted and, within the narrow limits at hand, all space was extremely well utilised.

The new vessel, "Biologen", for which a government grant was made in the spring of 1932, was designed by Aage Larsen, Naval Engineer in Chief of the Ministry for Shipping and Fisheries, under the supervision of Mr. F. V. Mortensen, Director of Fisheries, and in collaboration with the Director of the Danish Biological Station. The beautiful lines of the ship appear on the photograph reproduced

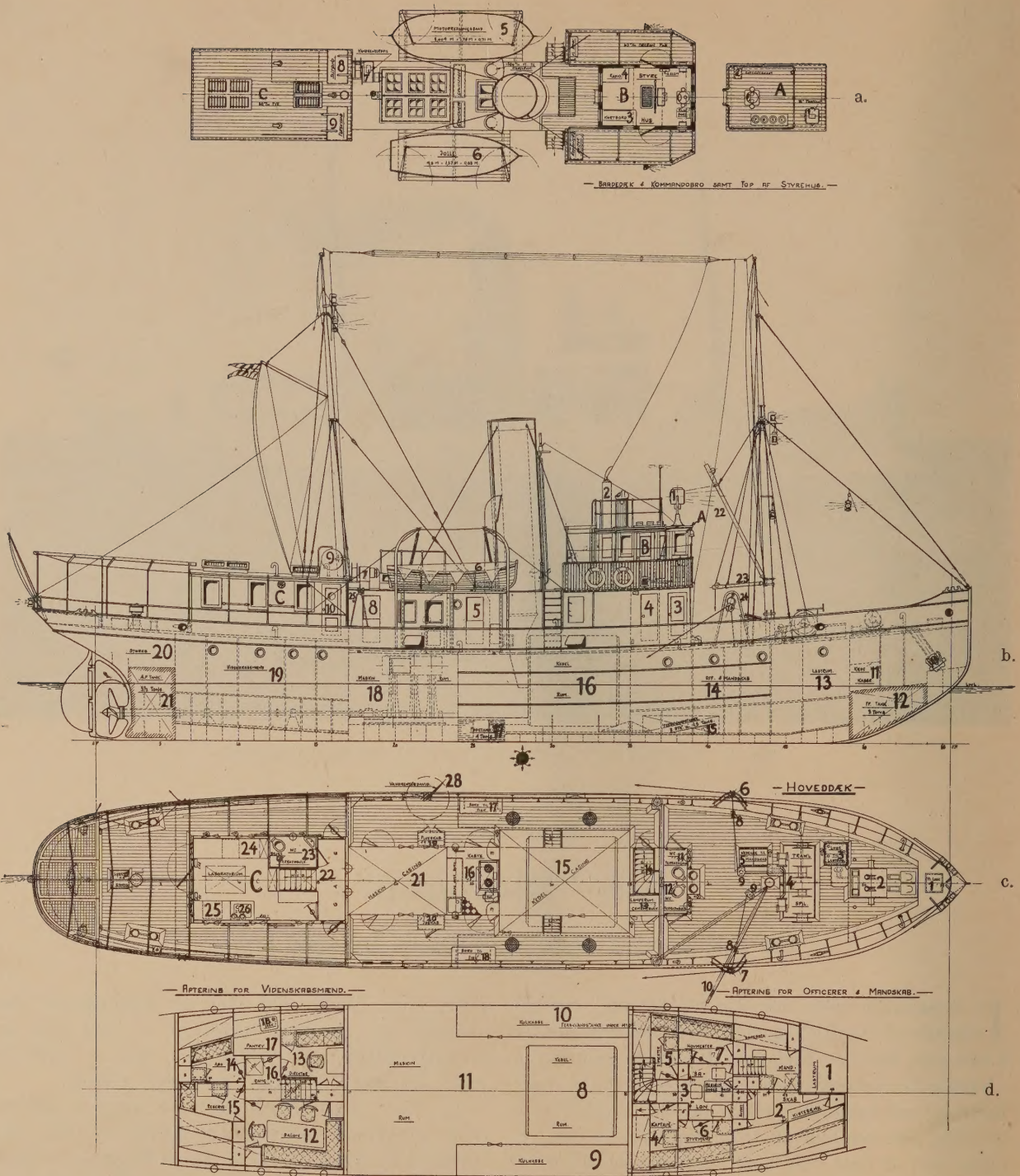

Fig. 2. S/S "Biologen", general arrangement. Scale about 1 : 200.
Explanation of the figures see page 5.

(Fig. 1) and the general arrangement in Fig. 2. She was built by the Aalborg Skibsværft (Ship-Yard) and was handed over on Sept. 24th, 1932.

The ship is 143 tons gross, 52 tons net. The dimensions are:

Length P. P.	30.00 m
Breadth to moulding frames	6.25 -
Depth from main deck to top of keel	3.10 -

S/S "Biologen" is built of steel and fitted with a four-bladed bronze propeller. The engine, made by A/S Frichs, Aarhus, is a triple expansion engine with Klug's parallel motion. The dimensions of the cylinders are 270 × 425 × 700 mm., and at a pressure of 13 atmospheres and 160 rotations a minute it exerts 260 indicated h. p.; the steam is generated by a high-cylindrical marine boiler with a heating surface of 90 m². The boiler, which is coal burning, was built by the ship-yard. At the full-power trial the ship kept 9 knots, but the economic speed is 8 knots only. The bunkers (9 and 10 in Fig. 2 d) hold 20 tons.

The draught with full bunkers is 2.5 m. (8′3″). Engine- and boiler space (16 and 18 in Fig. 2 b, 8 and 11 in Fig. 2 d) is amidships. Forward of this place are the officers' accomodations (14 in Fig. 2 b and 3—7 in Fig. 2 d) with ward-room (3 in Fig. 2 d), cabins for captain (4 in Fig. 2 d), chief engineer (5), mate (6), and steward (7); abaft the engine are accomodations for scientists (19 in Fig. 2 b and 12—16 in Fig. 2 d) and their mess (12 in Fig. 2 d) and special cabins for the Director (13), the Assistant (14), and 2 passengers (15) as well as a pantry (17). Accomodation for the crew with room for 5 men is in the forecastle (13 in Fig. 2 b and 2 in Fig. 2 d).

The laboratory (C in Fig. 2 b, C in Fig. 2 c and Figs. 3—4) is on the aft-deck. The arrangement of this room is based on experience gained through many years of work onboard the old research vessel, and offers splendid accomodation for both 3 and 4 persons working simultaneously. Plenty of light and air is allowed to the laboratory through a skylight and 7 large windows, 2 of which, viz. those of the aft bulkhead, are sash-windows. Microscopes and other implements for scientific use are fixed conveniently and within reach from the seats, and there is a porcelain sink at the starboard side (26 in Fig. 2 c, and Fig. 4) with taps for fresh and salt water from tanks on the roof of the laboratory (8 and 9 in Fig. 2 a).

The electric plant comprises the wireless, placed in the wheel-house (4 in Fig. 2 a), the search-light on top of the wheel-house (1 in Fig. 2 b), an electromotor on top of the engine-casing (7 in Figs. 2 a and 2 b), as well as lighting of accomodations, engine- and boiler-rooms, stowage-rooms, side-, top-, and anchor-lights, two binnacles-lanterns, two telegraphs, Morse-lamp, and deck-light. The wireless has a range of about 100 naut. miles. The search-light is fitted with incandescent light of 3000 watt. The electric power is supplied by a 110 v. D. C. compound dynamo directly coupled to a "Reader" steam-engine with one cylinder.

The trawl-winch (4 in Fig. 2 c, Figs. 5—7) is placed on the fore-deck and fitted with four drums.

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a) Boat-deck and captain's bridge with top of wheel-house. — A. Top of wheel-house with search-light (1, at bottom, right) compass (in the median line) and antenna shaft (2, at top, left). B. Wheel-house. 3: Chart table. 4: Wireless station. 5: Motor life-boat. 6: Dingy. Between the boats, engine shylight and behind the latter at the port side 7: Electric winch for water-sampler. C. Laboratory. 8: Salt water tank. 9: Fresh water tank.

b) Section from stem to stern. — A, B and C s. sub a. 1: Search-light. 2: Antenna shaft. 3: Lavatory. 4: Lightroom. 5: Hatch for top of boiler. 6: Dingy. 7: Electric winch. 8: Companion way to engine-room. 9: Fresh water tank. 10: Entrance to principal cabin. 11: Chain-pipe. 12: Forepeak tank, 3 tons. 13: Stowages. 14: Officer's and crew's accomodations. 15: Fresh water tanks, 2 × 1.5 tons. 16: Boiler-room. 17: Feeding tank, 4 tons. 18: Engine-room. 19: Accomodations for Scientists. 20: Stores. 21: Aftpeak tank, 3.5 tons. 22 and 23: Beams with gauges for bottom-sampler and Hensen-Net. 24: Trawl gallows. 25: Water-sampler davit for deep water use.

c) Main deck. — 1: Companion way to forepeak. 2: Winch. 3: Hatch of stowage room. 4: Trawl winch. 5: Companion way to forecastle. 6 and 7: Trawl gallows. 8: Leading blocks with gauges for trawl-wire. 9: Leading blocks on deck for trawl-wire. 10: Beams with gauge for bottom-sampler and Hensen-Net. 11 and 12: Lavatories. 13: Lightroom. 14: Companion way to Officer's ward-room and cabins. 15: Boiler casing. 16: Caboose. 17 and 18: Work-tables. 19: Meat-safe. 20: Refrigerator. 21: Engine casing. 22: Entrance to principal cabin and laboratory. 23: Lavatory and bath. 24 and 25: Work-tables in laboratory. 26: Sink with drain. 28: Water-sampler davit for use in shallow water.

d) Accomodations. — 1: Stowage. 2: Forecastle for 5 men. 3: Ward-room. 4: Captain. 5: Chief engineer. 6: Mate. 7: Steward. 8: Boiler. 9 and 10: Bunkers. 11: Engine room. 12: Cabin. 13: Director. 14: Assistant. 15: Spare room with 2 berths. 16: Companion way. 17: Pantry. 18: Sink.

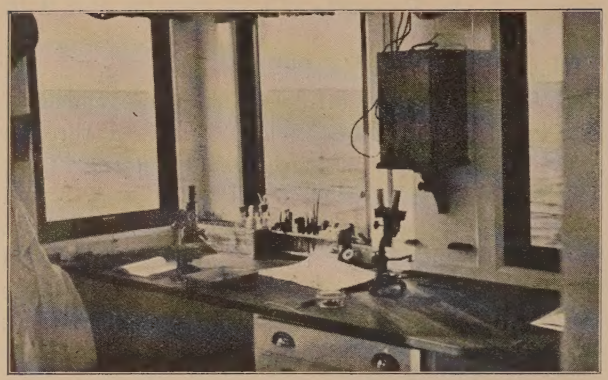

Fig. 3. Corner of laboratory.

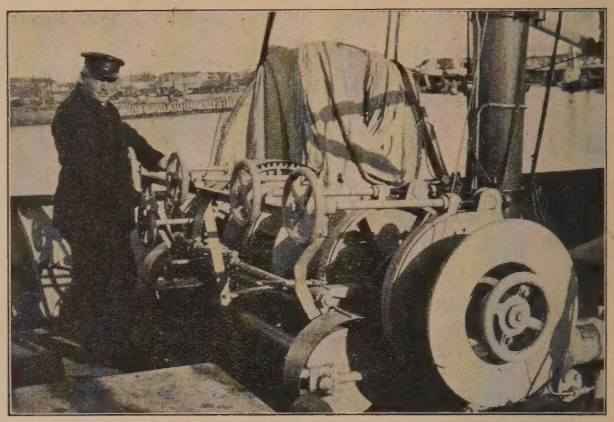

Fig. 6. Trawl winch. At the back, the ringtrawl.

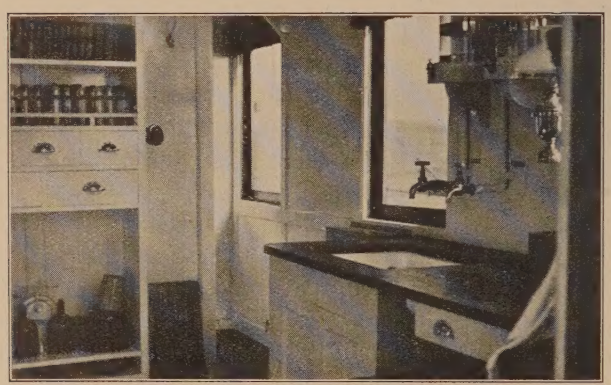

Fig. 4. Part of laboratory from abaft. Sink with taps for fresh and salt water. Above taps, tanks with alcohol and formalin for direct tapping.

Fig. 7. Stem of "Biologen" with trawl winch and leading blocks on deck with trawl gallows.

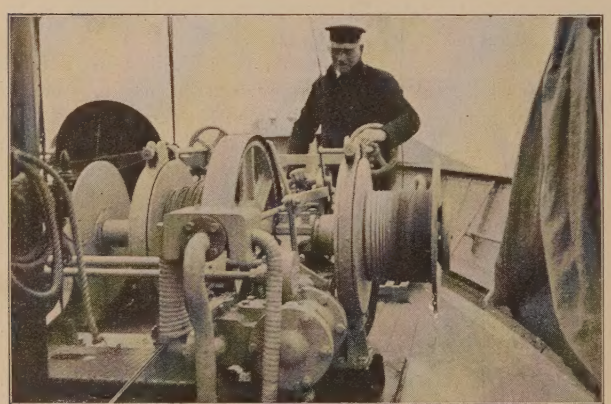

Fig. 5. Trawl winch.

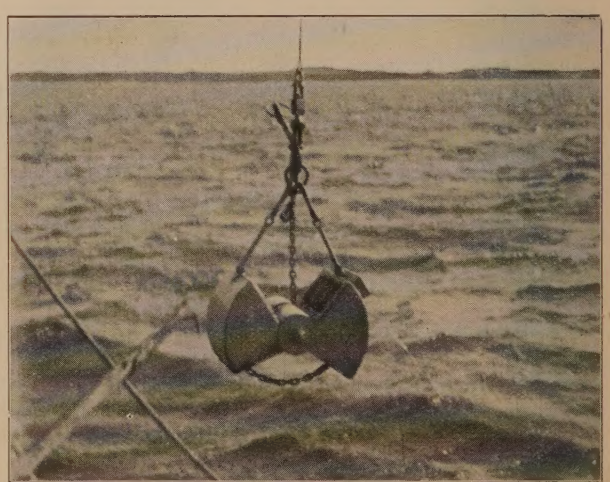

Fig. 8. Bottom-sampler ready for lowering.

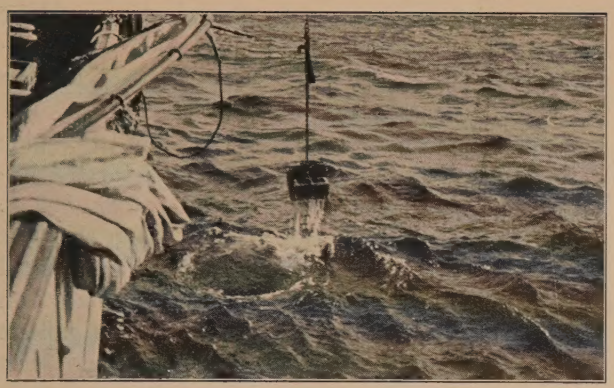

Fig. 9. Hauling in of bottom-sampler.

Fig. 12. Hauling in of ring-trawl.

Fig. 10. Contents of bottom-sampler is washed out in sieves.

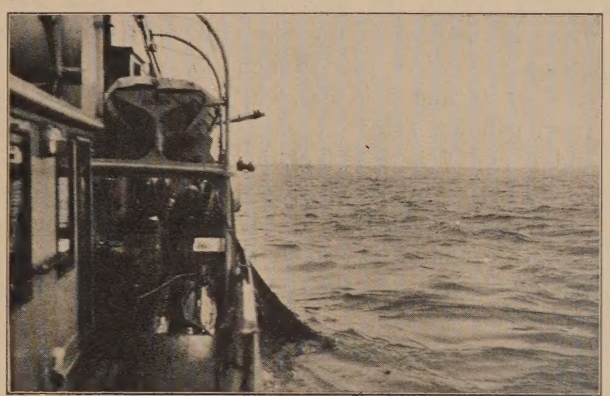

Fig. 13. Otter-trawl is hauled in.

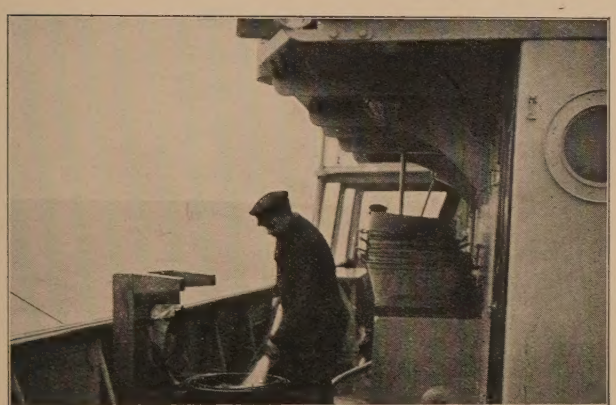

Fig. 11. Material from bottom-sampler is washed through sieves.

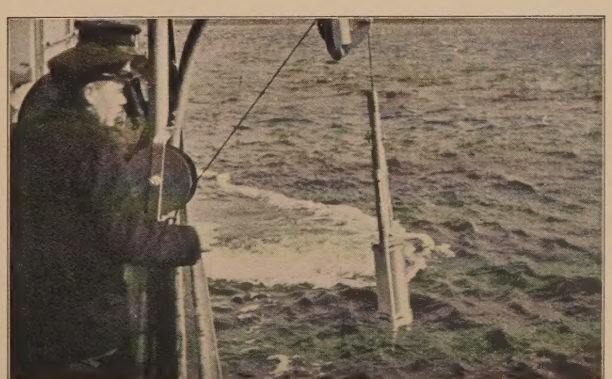

Fig. 14. Hauling in of water-sampler.

The largest of these holds 700 m. of 12 mm. wire, a smaller one 300 m. of 12 mm. wire. On the ends of the shaft two drums are placed, one for 700 m. of 5 mm. wire, the other for 200 m. of 5 mm. wire. The two latter drums are mainly used for vertical hauls with the bottom-sampler (Figs. 8—10) and the Hensen-Net. For the paying out of the gears, two beams are used (22 and 23 in Fig. 2 b and 10 in Fig. 2 c); they can be swung out in order that the gears may run clear of the side. At the ends of the beams are measuring gauges; the wires run from the drums through pulleys fixed on the fore-mast, through the gauges to the gears. The metres are faced such that they can easily be read by the person attending the gears.

The other two drums are used for horizontal hauls with trawl, both ring-trawl (Fig. 12) and otter-trawl (Fig. 13); ordinarily, when mainly working on smaller depths, the small drum is used; the large drum is required in the Skagerak only. From the drums the wires run through two leading-blocks on deck (8 and 9 in Fig. 2 c, s. also Fig. 7) to the trawl gallows, fitted at each side (24 in Fig. 2 b and 6 and 7 in Fig. 2 c), in order that two different horizontal trawling gears can be used alternately; consequently it is not necessary to change the gears and, thus, much time is saved. On the leading-blocks below the trawl gallows are measuring gauges which can be read by the winchman. Along the starboard as well as the port side, two flap-tables are placed (17 and 18 in Fig. 2 c) for the sorting of materials etc.

A small electro-motor, placed on top of the engine casing (7 in Figs. 2 a and 2 b), is used for the hydrographic work and works a drum with 800 m. of 3.5 mm. wire. From this electric winch the wire runs through a block with measuring gauge, fixed in a davit (25 in Fig. 2 b); one davit is placed on each side of the ship; they are shaped as gallows and made to swing back above the gunwale when not in use.

For the working of the water-sampler at smaller depths a davit with hand windlass is fixed at port (28 in Fig. 2 c, and Fig. 14).

A dingy (6 in Figs. 2 a and 2 b) and a motor life-boat with a 6 h. p. "Solo" motor (5 in Fig. 2 a) is placed on a boat-deck on top of the engine casing.

Otherwise, the accomodation of the ship as to stowage, water tanks, lightroom, caboose, bath-rooms etc. will be seen from the general arrangement in Fig. 2 and the explanation appended.

The time during which the ship has been used has proved it to be fully suited for its purpose, viz. fishery investigations in the North Sea from Thyborøn-Kanal and northwards, in the Skagerak, the Kattegat, the Belts, and the Baltic.

ERIK M. POULSEN:

Biology of the Dab in Danish Waters.

Introduction.

Due to the increasing intensity of the fishing of plaice the quantity of this fish in our waters, within the Skaw, is decreasing; this fact has caused our fisheries to pay greater attention to other flat fish like the dab and the flounder.

Derived from the statistics of Fiskeri-Beretningen, Fig. 1, shows the total yield of the Danish dab fishery during the years 1909—31. The figure shows that in the years 1909—11 the annual catches amounted to about 200 000 kg. only, whereas the yield of the years 1912—14, had already risen to about 500 000 kg. per annum. During the Great War 1915—18, the fluctuations of the yields varied very much, the average figure being 1 200 000 kg. During the years after 1920, there was a strong and steady increase of the catches, and in 1931, the total yield reached a height of about 3 600 000 kg. But

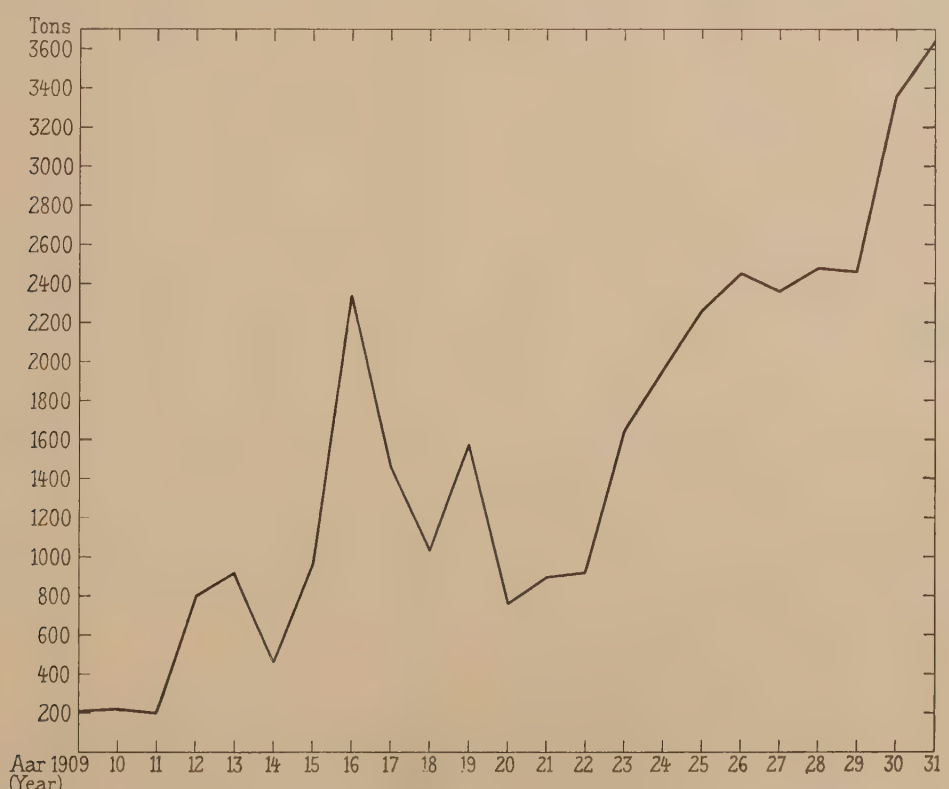

Fig. 1. Yield in metric tons of the Danish dab fishery during the years 1909—31.

Tab. 1. Yield in tons of the Dab fishery in Danish waters.

Aar *Year*	Nordsø[1]) *North Sea*[1])	Skagerak	Kattegat	Øresund *the Sound*	Bæltehavet *the Belt Sea*	Vestlige Østersø *Western Baltic*	Egentlige Østersø *Baltic proper*	Hele Danmark *All Denmark* Udbytte i *Yield in* Tons	Kroner	Pris *Price* pr. kg Øre	Middelpris for alle Fisk *Mean price for all fishes* Kr. pr. kg	% Værdi af Isingfiskeriet af hele Fiskeriudbyttet % *Value of dab fishery to all Danish fisheries*
1931	201	58	1 045	40	1 057	159	831	3 628	714 124	20	38	2.08
1930	172	95	1 150	46	850	135	764	3 371	706 751	21	44	1.74
1929	172	114	916	15	592	51	420	2 414	526 216	22	43	1.38
1928	97	96	1 267	20	775	39	20	2 479	549 340	22	39	1.50
1927	90	12	1 363	28	657	39	31	2 385	460 167	19	40	1.36
1926	117	3	1 452	22	577	38	34	2 457	468 812	19	46	1.31
1925	262	1	1 252	10	496	15	22	2 283	537 511	24	57	1.21
1924	268	0.2	913	22	532	4	9	1 943	550 937	28	65	1.23
1923	198	0.2	772	40	560	9	8	1 661	353 423	21	50	1.04
1922	120	..	361	14	321	0.1	6	922	206 736	22	53	0.77
1921	126	..	396	6	285	0.2	4	907	232 749	26	59	0.65
1920	75	..	417	12	282	0.4	3	789	206 261	26	65	0.49
1919	51	19	907	5	588	..	4	1 575	410 256	26	51	0.76
1918	127	..	593	8	328	..	5	1 061	306 732	29	64	0.73
1917	194	43	646	15	575	..	2	1 474	358 026	24	56	1.02
1916	720	38	816	28	757	..	6	2 364	507 600	21	62	0.88
1915	152	..	452	13	370	5	3	995	118 537	12	40	0.44
1914	116	..	106	..	217	..	7	446	34 962	8	33	0.20
1913	373	..	111	..	448	..	4	937	51 212	5	29	0.29
1912	647	..	79	..	75	..	10	806	39 597	5	29	0.24
1911	86	..	48	..	60	..	11	205	27 136	13	29	0.18
1910	108	..	174	..	47	..	10	236	21 267	9	..	0.18
1909	73	3	65	..	57	..	12	231	..	..	..	..

[1]) Kun Fangst landet i danske Havne medtaget. *Only quantities landed in Danish harbours included.*

this rise appears in the waters within the Skaw only — i. e. in the very waters where the stock of plaice has been subject to the strongest persecution. At the beginning and the end of the whole period the annual average yields of the different waters were as follows:

Series of years	North Sea & Skagerak	Kattegat	Belt Sea	Proper Baltic
	metric tons	metric tons	metric tons	metric tons
1909—14	235	97	151	9
1926—31	142	1 199	751	350

In the North Sea there has been no rise whatever, but in the Kattegat the yield has risen to 10 times, in the Belt Sea to 5 times, and in the proper Baltic even to 40 times the former quantities. In accordance with this great rise in the quantity of cathes there has been a rapid increase in the profits of our dab fishery. In the years 1909—14, the value of catch per year averaged about 40 000 Kr. only as compared to an annual average sum of nearly $^3/_4$ million Kroner in 1930 and 31. In the same period the price per kg. rose from 8 Øre to 21 Øre. These figures alone prove the rapidly increasing importance of the Danish dab fishery during those 20 years. But the rise is still more pronounced when we compare the alterations of the profits of the dab fishery with those of our other fisheries (see Table 1). In the years about 1910 the value of the dab fishery amounted to 0.2 per cent. only of the total value of all our fisheries, whereas in 1930 and 31, the value percentage was 2; i. e. it had risen tenfold. In 1910 the dab was no. 17 in importance among our food fish (incl. lobster and shrimp), but in 1930, it had come to be no. 8.

There is every reason to believe that the dab fishery will be still more intense in the years to come when people learn to know the excellent food this fish offers, and thus the question is bound to arise in the near future whether there is a reason

for introducing regulations for the protection of the stock of dab or not.

Every fisherman knows, and, on the whole, so does any person who is interested in fishery, from sad experience that the stock of plaice of our inner waters has not been able to stand the ever growing intensity of plaice fishing. Again and again Danish fishing biologists have called attention to the rapid decrease of the quantity of plaice in our inner waters; partly they have pointed out certain methods of protecting the stock of plaice and partly recommended transplantations of undersized plaice to certain inner waters from outer ones. It is true that several protection acts have been passed in the course of time, and during these late years the Government has defrayed the expenses of transplantations of young plaice from the North Sea to the Belt Sea and the adjacent waters. But there is no denying that the way to the introduction of certain measures has been long and troublesome; and to all appearance several protective measures have not been introduced until it was too late or, at any rate, they were not introduced at a time to yield the best profit of these arrangements.

The dab still occurs numerously throughout our waters, but there is reason to believe that a rising fishing intensity will affect the stock of dab in much the same way as it has affected the stock of plaice and that the question will suggest itself to what degree and in what way the stock of dab ought to be protected. However, a rather intimate knowledge on the biology of the dab is necessary for making the right arrangements for the preservation of the stock. The following is based on material collected throughout the years by the Danish Branch of Kommissionen for Danmarks Fiskeri- og Havundersøgelser and by the Danish Biological Station, and gives a preliminary statement of the biology of the dab. The statement, as mentioned, will only be a preliminary orientation, as the material was not collected for the purpose of special investigations of the dab, but originates mainly from experimental fishings made in order to throw light on the biological conditions of the plaice.

The Occurrence of the Dab in Our Waters.

The dab occurs throughout our waters, and everywhere — except in the Limfjord and some inner waters — dab fishing takes place; this will be seen from the survey below of the average catches of the years 1928—31:

	Average catches in tons in the years 1928—31
The North Sea	161 metric tons
The Skagerak	91 — —
The Kattegat	1 095 — —
The Sound	30 — —
The Belt Sea	819 — —
The Western Baltic	96 — —
The Baltic Proper	506 — —

This shows that the heaviest catches of dab are made in the Kattegat and the Belt Sea, and next comes the Baltic proper. In the North Sea the dab fishery is but small and quite insignificant in comparison to the plaice fishery. However, in the Belt Sea and the Baltic proper the dab fishery is already at present equal to the plaice fishery in weight — though of course not in value. Consequently it is especially the population of dab in our inner waters (the waters within the Skaw) that is of economic interest, and, therefore, especially the dab population of these waters will be made the object of investigation in the following.

If we consult the fishing experiments made throughout the years in our waters, partly with a 50 feet otter-trawl from the "Thor" and the "Dana", partly with the eel-tog from the "Japetus Steenstrup", we may get a notion of the distribution and frequency of the dab in our different waters and at different zones of depth (Tables 2 and 3).

The fishing on which Tables 2 and 3 are based has been carried out in different seasons of the year and the results must be taken as a survey of the "average" distribution of the dab; I have not found the material large enough to bear an investigation into seasonal migrations.

It appears from Table 2 that, generally speaking, the population of dab is denser in the North Sea (only the parts of the North Sea adjacent to the Danish coasts have been taken into consideration) than in our inner waters. From the North Sea the dab enters the Limfjord, where especially the Nissum Broad is richly populated, whereas the populations of the inner broads are small in numbers. (The occurrence of dab in the Limfjord will be submitted to a closer investigation in a later section on p. 25).

Also, it appears from Table 2 that the most numerous occurrence of the dab is inside the 20 m.

Tab. 2. Catch of Dab in Ottertrawl from »Thor« (1903—11) and from »Dana« (1922—30) in Danish waters.

Aar *Year*	1903—11 Antal *Number of*				1922—30 Antal *Number of*			
	Stat.	Fisketimer *Fishing hours*	Ising *Dab*	Ising pr. Time *Dab pr. hour*	Stat.	Fisketimer *Fishing hours*	Ising *Dab*	Ising pr. Time *Dab pr. hour*
Nordsøen *North Sea*:								
1—10 m	6	10	4 125	413	6	3½	1 627	465
11—20 -	49	111	24 613	222	32	19¼	17 237	896
21—40 -	48	110	16 764	152	44	38½	13 859	360
41—60 -	18	51	7 004	137	9	12	3 688	307
61—80 -	1	1	100	100	..	..	..	..
Ialt *Total*	122	283	52 606	186	91	73¼	36 411	497
Skagerak:								
1— 10 m	6	8	1 437	180	6	5½	1 584	288
11— 20 -	16	46	3 323	72	10	9½	563	59
21— 40 -	6	9	2 266	252	3	2½	58	23
41— 60 -	5	6	145	24	..	..	..	..
61— 80 -	5	7	734	105	..	..	..	..
81—100 -	6	32	42	1	2	3	1	0.3
101—140 -	6	12	3	0.3	1	1	0	0
141—200 -	7	12	18	1.5	..	..	..	..
201—300 -	7	18	1	0.1	2	3	0	0
>300 -	14	30½	0	0	1	2	0	0
Ialt *Total*	78	180½	7 969	44	25	26½	2 206	83
Kattegat:								
1— 10 m	25	73	10 807	148	6	3	278	93
11— 20 -	47	153	21 956	144	7	6½	879	135
21— 40 -	66	243	27 958	115	5	5	330	66
41— 60 -	13	33	2 297	70	1	2	329	165
61— 80 -	4	10	217	22	..	..	..	..
81—100 -	1	1	40	40	..	..	..	..
Ialt *Total*	156	513	63 275	123	19	16½	1 816	110
Øresund *The Sound*:								
1—10 m	1	¼	20	80	..	..	..	..
11—20 -	1	1½	224	149	..	..	..	..
21—40 -	1	2	4 753	2 377	..	..	..	..
Ialt *Total*	3	3¾	4 997	1 333	..	..	..	..
Bælthavet, Vestlige Østersø *Belt Sea, Western Baltic*:								
11—20 m	6	11¼	2 662	236	1	1	21	21
21—40 -	2	1	265	265	9	11½	653	57
Ialt *Total*	8	12¼	2 927	239	10	12½	674	54
Egentlige Østersø V. f. 14° Ø. *Baltic proper W. of 14° E.*								
11—20 m	8	20¼	2 517	124	3	1⅚	13	7
21—40 -	5	4½	697	155	6	5	360	72
41—60 -	1	1½	199	133	4	6	1 393	232
Ialt *Total*	14	26¼	3 413	130	13	12⅚	1 766	137
Egentlige Østersø Ø. f. 14° Ø. *Baltic proper E. of 14° E.*:								
1— 10 m	1	1	9	9	3	2½	0	0
11— 20 -	2	2½	44	18	3	2	0	0
21— 40 -	..	..	..	..	1	½	21	42
41— 60 -	..	..	..	..	4	2¾	372	135
61— 80 -	1	1	64	64	4	4¾	1 857	391
81—100 -	1	½	16	32	2	1½	414	277
Ialt *Total*	5	5	133	27	17	14	2 664	190

Tab. 3. Catch of Dab in »Tog« from »Japetus Steenstrup« in the years 1927—32.

	Antal *No. of* Stat.	Fisketid Min. *Duration of fishing*	Antal Ising *Number of Dab* Ialt *Total*	fanget pr. ½ Time *caught pr. 30 min.*
Skagerak:				
1—10 m		75	83	33
11—20 -		255	517	61
21—40 -		300	803	80
41—60 -		30	62	62
61—80 -		30	13	13
Ialt *Total*	26	690	1 478	75
Kattegat:				
1—10 m		2 440	4 625	57
11—20 -		2 370	15 428	195
21—40 -		2 940	11 602	118
41—60 -		335	398	36
61—80 -		30	22	22
Ialt *Total*	309	8 115	32 075	119
Øresund *The Sound*:				
1—10 m		30	15	15
11—20 -		590	262	14
21—40 -		210	65	9
Ialt *Total*	36	830	342	12
Bælthavet *The Belt Sea*:				
1—10 m		1 450	888	18
11—20 -		6 093	20 930	103
21—40 -		3 000	4 875	49
41—60 -		25	44	53
Ialt *Total*	424	10 568	26 737	76
Vestlige Østersø *Western Baltic*:				
1—10 m		70	29	12
11—20 -		265	347	39
21—40 -		605	998	49
Ialt *Total*	34	940	1 374	43
Egentlige Østersø V. f. 14° Ø. *Baltic proper W. of 14° E.*):				
1—10 m		85	2	1
11—20 -		650	296	14
21—40 -		835	346	14
41—60 -		230	387	50
Ialt *Total*	64	1 800	1 031	17
Egentlige Østersø Ø. f. 14° Ø. *Baltic proper E. of 14° E.*):				
1— 10 m		150	5	1
11— 20 -		285	64	7
21— 40 -		585	826	42
41— 60 -		510	603	35
61— 80 -		140	128	27
81—100 -		345	523	45
Ialt *Total*	70	2 015	2 149	32

curve; the number of individuals taken per hour is twice the number taken between 20 and 60 m. In the Skagerak, too, the dab is most frequent inside 20 m.; at intermediate depths it is not so numerous and outside the 100 m. curve there are very few dab; at depths of more than 200 m. it has not been caught during the experimental fishings at all. In the Kattegat the trawlings of the "Thor" and the "Dana" showed that dab occur in the greatest number inside a depth of 40 m.; in deeper water it is less numerous. In the Belt Sea, the Sound, and the western Baltic only few hauls have been made with the trawl, but here the numbers caught seem to indicate a distribution that is somewhat different to that of the North Sea, the Skagerak and the Kattegat; here we find, namely, somewhat higher numbers at depths outside the 20 m. contour than at depths inside this line. In the Baltic proper this fact is still more obvious. Inside the 10 m. contour the population is very thin. Between 10 and 20 m. there is a somewhat denser population, yet not nearly as dense as at the same depths in the rest of our waters. In the Baltic proper the greatest density is reached at depths as high as 60 to 80 m. In still deeper water, in the Bornholm Deep between 80 and 100 m., the population is once more somewhat thinner, in all probability due to the shortage of oxygen at certain seasons, at these depths, in the Baltic.

Similar figures for the distribution of the dab are recorded in the results of the eel-tog fishings from the "Japetus Steenstrup" (Table 3). In the Skagerak and the Kattegat the greatest quantities are recorded at depths of 10 to 40 m., the quantity decreasing from 40 m. and outwards. In the Belt Sea the population is rather thin inside the 10 m. line. The greatest density is found between 11 and and 20 m., but also in deeper water — between 20 and 60 m. there is a comparatively dense population. Already in the western Baltic conditions are different; here the density of the stock increases with the depth; on the whole, the same conditions hold good for the Baltic proper.

On the basis of the figures in Table 2 Fig. 2 shows the distributional conditions for the North Sea, the Kattegat, and the Baltic proper; from each water the series of investigation is taken comprising most hauls with the trawl (from the North Sea and the Kattegat the years 1903—11, and from the Baltic the years 1922—30). It appears distinctly from the investigations that in the North Sea and the Kattegat we find most dab in shallow water, the quantity

decreasing with the increasing depth. In the Baltic, however, the thinnest population occurs in shallow water, the stock increasing in density with the depth, apart from the deepest parts of the Baltic where there is shortage of oxygen.

The cause of this peculiar difference in the distribution of the dab in the North Sea and the Kattegat on one side and in the Baltic on the other is no doubt the low salinity of the latter water as compared to the two former ones. In the Baltic the dab advances as far as to the western coast of Gothland, where it is found at depths of about 30 m. but twice the salinity of the coastal water. Thus we notice that the low salinity of the coastal water compels the dab of the Baltic to live at comparatively greater depths than elsewhere in our waters. Talking about this it is worth noting that the same characteristic distribution has been demonstrated for the cod of the Baltic (Erik M. Poulsen, 1931)[1]; while in the rest of our waters cod are at least as numerous in shallow as in deep water, by far the greater part of the Baltic cod is found in deep water, the shallow coast water showing a scarse population of cod only.

That the stock of dab is very dense in our waters

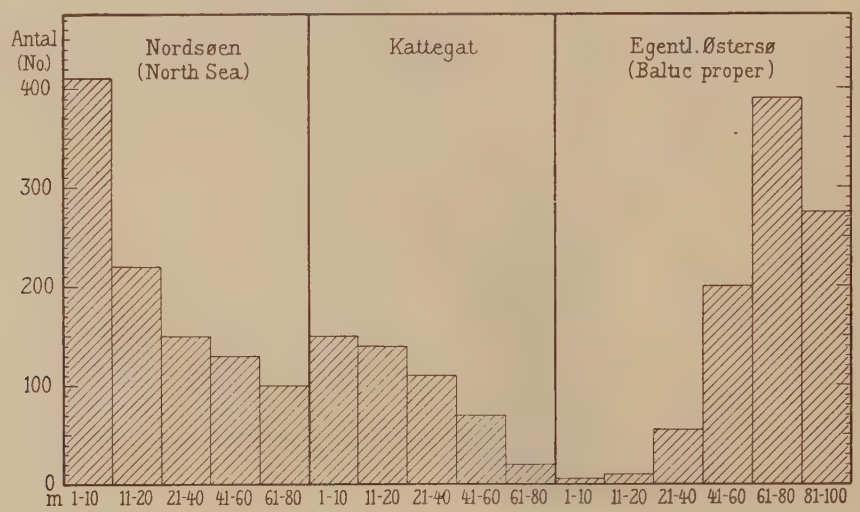

Fig. 2. Number of dab taken per trawl-hour in different depth-zones in the North Sea (1903—11), the Kattegat (1903—11) and the Baltic proper (1922—30).

occasionally only in more shallow water (Chr. Hessle, 1923)[1]; i. e. in the Baltic the inner boundary for the occurrence of dab is found at a salinity of about 7 ‰.

But now a salinity of about 7 ‰ exists in the surface water of the Bornholm Deep, and even in the area W. of Bornholm (the Arkona Basin) the salinity of the surface water is no more than 7 and 8 ‰. Thus, the low salinity is undoubtedly the reason why the dab of the Baltic keeps clear of the shallow coastal areas to such a high degree, for in deeper water it will find the salinity to be a good deal higher. At depths of 40 to 80 m., both in the Arkona Basin and the Bornholm Deep, we find a salinity of about 13 to 15 ‰, and this is more than

from depths of a few metres and up to about 20 m. is due to the fact that this depth zone is the nursery ground of the young dab. Table 4 gives a survey of the number of individuals from different age-groups and different zones of depth in the Kattegat and the Belt Sea; this survey is based on fishing experiments carried out with the eel-tog from the "Japetus Steenstrup" during the years 1927—32. It is evident that both in the Kattegat and the Belt Sea the individuals of the I-Group are by far most frequent between depths of 10 and 20 m. Within this zone of depth 129 individuals were caught per 30 minutes in the Kattegat and 73 per 30 minutes in the Belt Sea; in the other zones only 6 to 43 were caught per 30 minutes, the number decreasing with

[1]) Chr. Hessle: Undersökningar rörande sandskädden (*Pleuronectes limanda*) i mellersta Östersjön. Medd. kungl. Lantbruksstyrelsen Nr. 243, 1923.

[1]) Erik M. Poulsen: Biological Investigations upon the Cod in Danish Waters. Medd. Komm. f. Danmarks Fiskeri- og Havunders. Serie Fiskeri. Bd. IX Nr. 1.

Tab. 4. No. of dab of different age groups caught in the »Tog« in various depth-zones in the Kattegat and the Belt Sea in 1927—32.

	Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Individer *No. of individuals* Total	Antal Individer af forskellige Aldersgrupper fisket pr. $^1/_2$ Time *No. of individuals of different age-groups caught pr. 30 min.* 0-	I-	II-	III-	IV-	V-	VI-	VII-	VIII-Gr.
Kattegat:												
3—10 m	40	900	3 012	0.1	43	18	5	0.3	0.1	..	..	..
11—20 -	27	775	4 875	0.04	129	49	9	1	0.1	..	..	..
21—40 -	28	845	1 519	0	14	27	11	1	0.2	0.1	..	..
41—60 -	3	80	57	0	6	14	1	1	..	..	..	..
Bælthavet *the Belt Sea*:												
3—10 m	5	120	300	0	37	7	20	8	3	0.5	..	..
11—20 -	76	1 860	9 054	2	73	34	20	11	4	2	0.3	0.1
21—40 -	44	1 140	2 104	0.1	19	23	10	2	0.3	0.3	0.1	0.1

the depth. The II-Group, too, shows the largest number of individuals at depths of 11 to 20 m., while the older age-groups — which are mature or approaching the stage of maturity — are found mainly in somewhat deeper water. In quite shallow water, viz. 3 to 10 m., the dab population is not very dense nor are the younger age-groups found in as large numbers here as farther out at depths of between 10 and 20 m. During the experimental fishings with Johansen's Young Fish Trawl along the coasts at depths of about 1 to 3 m. the number of dab caught is next to nothing, but it is well-known that these fishings bring a great many young plaice. Thus there is a distinct biological difference between the dab and the plaice with regard to the occurrence of the 0- and I-Groups: the youngest age-groups of plaice are most numerous in the quite shallow water along the coast, whereas the habitat of the corresponding age-groups of the dab is the somewhat deeper water between the 10 and the 20 m. lines. As to the occurrence of the 0-Group we know but little from the eel-tog fishings, for as late as September (the last month of the year in which this experimental fishery is carried on extensively) the 0-Group has not attained such a size, that representative quantities are caught in the tog. However, we get information on the occurrence of the 0-Group through the fishing experiments made with the trawl (with fine-meshed codend) and with Petersen's young fish trawl from the "Thor" and the "Dana". With Petersen's young fish trawl individuals of the 0-Group, about 4 cm. in size, were caught in the North Sea and the northern Kattegat during September, both in deeper and in more shallow water (see p. 19).

The distribution of the size-groups of dab in the North Sea is investigated on the basis of length-measurings of some 28 000 individuals. In the North Sea as well as in the Kattegat the bulk of the small dab of 2 to 5 cm. in length (6 to 12 months old) is found at depths of 11 to 20 m., and neither in shallow nor deep water they are very numerous. A similar distribution is shown by the size-group of 6 to 10 cm., which also occurs in rather large quantities at depths of 21 to 40 m. Individuals of more than 11 cm. in length, however, are more numerous outside than inside the 20 m. line and are further found in considerable quantities at 41 to 60 m. of water. Thus we find that the young bottom-stages of the 0-Group in autumn and the I-Group in spring live in rather shallow water (but not in the quite shallow water along the coast-line like the plaice fry), and gradually, as the fry grows, it migrates into deeper water like the young plaice.

Racial Characters of the Dab.

The racial characters of the dab in the various Danish waters have not, as yet, been made the object of a special investigation, and thus the following will give some few and rather sparse analyses only of a small number of individuals.

Table 5 presents the material in hand: countings of vertebrae in about 350 individuals (individuals only with a normal vertebral column are included), and countings of anal fin rays in 533 individuals.

There are no great variations in the mean numbers found for vertebrae: 10.00—10.05 for Vert. precaudal, 30.11—30.49 for Vert. caudal and finally 40.15—40.51

Tab. 5. Racial Analises of Dab from Danish waters.

Hvirvler *Vertebrae*:

Lokalitet *Locality*	Horns Rev *Horns Reef*	Graadyb *Graadeep*	Skagerak	Sydvestlige Kattegat *S.W. Kattegat*	4 Sm. O.S.O. f.Hestehoved *4 M.E.S.E.of Hestehoved* Møen	5 Sm. O.S.O. f. Christiansø *5 M.E.S.E.of Christiansø* Bornholm	Øst f. Nexø *E. of Nexø* Bornholm
Dato *Date*	15-4-1905	31-1-1933	Nov. 1905	1903	14-1-1904	25-7-1903	21-2-1933
Aldersgruppe *Age-group*	?	II—IV	?	?	?	?	III—IX
Længde cm *Length cm*	?	17—26	?	?	?	?	20—33
Vert. præc. 9	..	2	..	..	..	1	3
Krop- 10	50	80	36	..	36	28	79
hvirvler 11	..	4	1	..	2	1	7
Ind. Antal *No.*	50	86	37	..	38	30	89
Middel *mean*	10.00	10.02	10.03	..	10.05	10.00	10.04
Vert. caud. 29	4	10	3	..	4	3	15
Hale- 30	30	43	14	..	24	15	50
hvirvler 31	16	29	19	..	10	12	23
32	..	2	1	..	..	..	1
Ind. Antal *No.*	50	84	37	..	38	30	89
Middel *mean*	30.24	30.27	30.49	..	30.16	30.30	30.11
Vert. Total 39	4	8	3	3	4	3	12
Antal Hvirv- 40	30	45	13	13	22	15	51
ler, ialt 41	16	29	20	7	12	12	26
42	..	2	1	..	..	..	..
Ind. Antal *No.*	50	84	37	23	38	30	89
Middel *mean*	40.24	40.30	40.51	40.17	40.21	40.30	40.15

Gatfinnestraaler *Anal fin rays*:

Lokalitet *Locality*	Graadyb *Graadeep*	Skagerak	Nordlige Kattegat *Northern Kattegat*	Store Bælt *Great Belt*	Øst f. Nexø *E. of Nexø* Bornholm
Dato *Date*	31-1-1933	29-7-1931	Mar. 1906	24-1-1933	21-2-1933
Aldersgruppe *Age-group*	II—VI			II—V	III—IX
Længde cm *Length cm*	17—26			20—35	20—33
Antal Straaler *No. of rays*					
48	..	..	..	..	1
49	..	..	1	..	3
50	..	1	..	..	7
51	..	..	5	2	20
52	2	..	9	9	9
53	5	2	13	28	29
54	10	2	21	40	21
55	12	5	24	53	7
56	14	8	16	27	8
57	19	7	5	8	1
58	13	7	4	2	1
59	14	11	..	1	..
60	10	..	1	1	..
61	3	7	..	1	..
62	..	1	1	..	..
63	..	1	..	..	..
Ind. Antal *No.*	102	52	100	172	107
Middel *mean*	56.85	57.56	54.50	54.61	52.82

for Vert. total. The highest average figure for the total number of vertebrae, viz. 40.51, was found in an analysis of 37 individuals from the Skagerak; next comes the North Sea with two analyses of 40.30 (84 ind.) and 40.24 (50 ind.). It is closely followed by the Baltic proper with 3 analyses: off Møen 40.21 (38 ind.), off Christiansø 40.30 (30 ind.), and E. of Nexø 40.15 (89 ind.). From the Kattegat we have one analysis of 23 individuals only with a mean number of 40.17. Thus the numbers of vertebrae are just slightly higher in the Skagerak and the North Sea than in the Baltic proper.

Another point concerning the vertebrae seems to indicate an obvious difference between the dab populations of the North Sea and that of the Baltic.

R. Kändler[1]) has called attention to the fact that the number of individuals with fused vertebrae, as far as plaice and flounder are concerned, is far more numerous in the inner Baltic than in the western Baltic and the North Sea. In an analysis of dab from the eastern Baltic (without any specified localities) Kändler also found a comparatively large number (viz. 13 per cent.) with fusions in the vertebral column; Kändler offers no comparison with material from the western Baltic or the North Sea. In the present material, however, I have counted the number of individuals with fused vertebrae in a sample from the North Sea and in one from the Baltic. In the Baltic sample (taken immediately E. of Nexø) fused vertebrae were found in 12 per cent. (i.e. in much the same number as in Kändler's sample from the eastern Baltic); however, in the North Sea sample (Graadyb) fused vertebrae occurred in 2 per cent. only of the individuals examined. Thus the Baltic dab (like the plaice and the flounder of the same water) is distinguished from the North Sea dab by the comparatively great number of individuals with fused vertebrae, and such anomalies in the vertebral column seem to be a characteristic of the Baltic stocks of a number of fish species, the inner boundaries of which are found in the Baltic.

Throughout our waters the number of anal fin rays varies a good deal. In the North Sea (Graadyb) the mean number of rays in a sample of 102 individuals was 56.85, and a sample from the Skagerak (52 ind.) even had a number of 57.56 rays. But inside this place the number of rays falls rapidly. In the northern Kattegat (100 ind.) it is 54.50, in the Great Belt (172 ind.) it is 54.61, and in the Baltic E. of Bornholm still lower, viz. 52.82. In other words the North Sea dab has 4 to 5 more anal fin rays than the Baltic dab, and the difference is thus just as big as that between the North Sea plaice (54 rays) and the Baltic plaice (50 rays).

Consequently, the preliminary result of race analyses of the dab populations of our waters is that the Baltic dab, as compared to the North Sea dab, is characterized by (1) a smaller number of anal fin rays, (2) a more frequent occurrence of anomalies in the vertebral column, and (3) very likely a smaller number of vertebrae.

The Spawning Time of the Dab.

During the work for protection of the stock of plaice in our waters it was determined, a few years ago, to introduce a "close season" in the Baltic, i. e. that it was not allowed to catch the plaice during the greater part of its spawning time. By this protection the advantage is gained, firstly, that more plaice are allowed to spawn and consequently that more fry is produced, secondly that the plaice is not fished for at a time when it is a poor article for the trade on account of the spawning. Thus, the precise determination of the spawning season of plaice has been a question, not only of theoretic-scientific interest, but also of practical interest to the fishermen, and the same reason is valable for a more precise determination of the spawning time of a fish like the dab, which is so closely related to the plaice.

According to A. C. Johansen[1]) the principal spawning time of the dab of the Belt Sea occurs in April—July. Ehrenbaum and Strodtmann[2]) state that the dab of the western Baltic spawns already in February and that the spawning in the waters E. of Bornholm is still going on in August, perhaps till the month of September even.

Heincke and Ehrenbaum[3]) say that the spawning of the North Sea dab extends over a long period,

[1]) Rudolf Kändler: Unsicherheiten bei Bestimmung der Wirbelzahl infolge Verwachsungserscheinungen. Journ. du Cons. VII, 3; 1932.

[1]) A. C. Johansen: Om Rødspætten og Rødspættefiskeriet i Bælthavet etc. Skr. udg. af Komm. f. Havunders., 7, 1912.

[2]) E. Ehrenbaum und S. Strodtmann: Die Eier und Jugendformen der Ostseefische. Wiss. Meeresunters. d. deutschen Meere, N. F. VI. Abt. Helgoland, 1904.

[3]) Fr. Heincke u. E. Ehrenbaum: Wiss. Meeresunters. d. deutschen Meere, N. F. Bd. III. Abt. Helgoland 1900.

Tab. 6. Stage of maturity (only stages IV—VIII included) of dab caught in various Danish waters in the months January—August.

Modenhedsgrad *Stage of maturity*		IV		V		VI		VII		VIII		Ialt
Sted *Locality*	Dato *Date*	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	*Total*
Graadyb *Graadeep*	31-I-33	2	41	1	53	1	..	..	..	..	..	98
Vestlige Limfjord *Western Limfjord*	9-17-VI-31	..	..	7	..	11	2	4	2	..	..	26
Sydvestl. Kattegat *Southwestern Kattegat*	31-III-05	1	33	2	66	62	5	..	2	..	..	171
— —	5-7-VI-31	..	..	30	37	119	44	3	11	..	1	245
Rundt Anholt *Round Anholt*	15-III-05	275				..	..	..	..	..	..	275
— —	28-II-03	98				..	..	..	..	..	..	98
4 Sm. V. f. Slettehage *Northern Belt Sea*	4-VI-31	..	..	1	4	30	15	..	..	..	..	50
Store Bælt *Great Belt*	22-III-05	..	..	..	28	..	..	..	..	..	..	28
— —	24-I-33	..	19	14	2	11	..	..	1	..	..	47
Øst f. Urehoved, Ærø *South of Funen*	2-V-05	..	..	13	57	..	..	..	..	..	..	70
Syd f. Møen *South of Møen*	8-13-V-28	..	..	..	2	27	4	..	..	..	..	33
Rundt Bornholm *round Bornholm*	21-II-33	12	44	14	23	..	..	..	..	..	..	93
Rundt Christiansø *round Christiansø*	14-VI-23	2	3	5	6	4	7	..	1	..	..	28
Rundt Bornholm *round Bornholm*	30-VII-07	..	..	..	..	..	35	..	5	..	..	40
— —	26-VIII-31	..	..	..	..	..	1	8	1	7	1	18

from the end of January to the middle of July. As principal spawning time are given the months of March—May.

In April 1925 W. Mielck[1]) found that the dab was beginning to spawn in the area round Bornholm.

As the eggs of the dab cannot with certainty be distinguished from those of the flounder, we cannot use collections of eggs for the determination of the spawning time but must confine ourselves to considering analyses of the stage of maturity in the spawning dab. In Table 6 I have given a series of analyses of maturity from various waters. Maturity IV means that eggs and sperm are but little developed but the said individuals will yet be able to breed during the coming spawning season; V denotes individuals, the eggs and sperm of which are nearly mature but which have not yet begun to spawn; VI denotes spawning individuals, VII, individuals that have just finished spawning, and VIII, finally, means that the sexual organs are about to recover after spawning, which has consequently taken place some time ago.

In a sample from Graadyb in the North Sea taken on Jan., 31st only one out of 98 individuals had begun to spawn while the bulk of them were not yet ready to spawn (maturity IV and V). In the western Limfjord spawning dab were found as late as June mixed with individuals that were ready to spawn and with others that were spent. These determinations corroborate what was mentioned above, viz. that the spawning of the North Sea dab extends over a comparatively long period (from February to June). From the Kattegat we have two analyses of maturity. In two samples from the end of February and the middle of March spawning individuals were not yet found, nor were any of them spent. At the end of March most of the males but only a small minority of the females had begun to spawn, and only two individuals out of 171 were spent. In an analysis from the beginning of June the majority of both males and females were spawning, part of them had not yet begun to spawn, and a considerably smaller number was spent.

An analysis from the Great Belt at the end of January shows that here the spawning has just commenced, 11 males out of a total of 72 individuals belonging to stage VI and one female being spent. As late as March spawning is but slow: 28 individuals examined all belonged to stage V. At the beginning of June spawning is in active progress. 45 out of 50 individuals were spawning, but none of them were spent. Obviously the principal spawning time in the Belt Sea occurs in May—June. In the western Baltic at the isle of Ærø the dab had not yet begun to spawn on May 2nd (1905). At Møen spawning was in good progress at the beginning of May (1928). In the waters round Bornholm there were no spawning individuals at the end of February 1933; at the

[1]) W. Mielck: Untersuchungen über die pelagische Fischbrut in der Ostsee in April 1925. Ber. d. deutschen wiss. Kom. f. Meeresf. N. F. II, 1926.

beginning of May (1908) there was ample spawning; at the middle of June (1923) there were some spawning but also many non-spawning individuals. At the end of July (1907) 35 out of 40 individuals were spawning and 5 were spent, and finally at the end of August 18 individuals showed one spawning, 9 that had just finished the spawning, and 8 that had spawned already some time ago. Consequently the principal spawning time of the dab in the waters round Bornholm seems to be the months of May—June.

We notice that everywhere in our waters the spawning of the dab extends over rather a long period; in the North Sea from January to June or July, in the Kattegat and the Belt Sea from February to June, and in the Baltic from April to August. Generally speaking, then, the spawning in our inner waters, especially in the Baltic, takes place later than in the North Sea. As compared to the plaice, the dab is a late spawner; in the Kattegat and the Belt Sea and partly in the Baltic the principal spawning season of the dab occurs at a time when, on the whole, the spawning of the plaice has come to an end.

The Growth of the Dab.

The larvae that are developed from the eggs during the first 6 months — in the North Sea during the months of spring but in the Baltic as late as August — grow in size during summer and early autumn, and in late autumn they begin to give up their pelagic habits and take to life at the bottom. In the North Sea, the first bottom-stages may be found already in June, but the bulk of the young dab do not migrate to the bottom until about two months later (E. Ehrenbaum, 1907)[1]). As late as October larval stages of the dab are found both in the North Sea, the Skagerak, and the Kattegat, where they are caught with the first, metamorphosed bottom-stages as proved by hauls made with Petersen's young fish trawl:

The North Sea

2-X-22, 80 m, y. f. trawl, near bottom, 2 hours, 90 larvae (6—19 mm) + 110 bott.-st. (12—20 mm)

— — — upper water layers, 2 hours: 58 larvae (10—18 mm)

3-X-22, 50 m, — interm. water layers, 2 hours: 55 larvae (10—20 mm)

The Skagerak

4-X-22, 47 m, y. f. trawl, interm. water layers, 2 hours: 44 larvae (9—15 mm)

10-X-22, 90 m, — at bottom, 3 hours: 14 larvae (10—13 mm) + 108 bott.-st. (12—20 mm)

11-X-22, 150 m, — at bottom, 2 hours: 6 larvae (12—18 mm)

15-X-22, 25 m, — near bottom, 30 min.: 2 larvae (11—12 mm) + 6 bott.-st. (13—19 mm)

Beside the last mentioned haul 15 hauls were made in the same waters in October 1922 at depths of 5 to 40 m., but none of them brought out any larvae of dab, however, in 7 out of 10 hauls made between depths of 40 and 150 m. larvae were found, but in hauls from depths of more than 150 m. the larvae were again missing. Thus we notice that as late as the first half of October pelagic, non-metamorphosed larvae still exist at intermediate depths in the North Sea; these larvae are about 10 to 20 mm. long.

But at this time of the year the metamorphosis of most dab-larvae must be supposed to have taken place, as in hauls with fine-meshed gear we find large quantities of young bottom-stages both in deeper and in more shallow water. The lengths of these young bottom-stages belonging to the 0-Group are given below.

Gear	Petersen's Young fish trawl at bottom					Otter trawl w. fine-m. codend	Johansen's Y. f. trawl
Place	Hanstholm	Horns Reef Area		Vyl	Lightship	Hirshals	Harbøre
Depth in m.	70	50	41	27	24	8	5
Date	$^{12}/_{10}$-22	$^{28}/_{9}$-04	$^{28}/_{9}$-04	$^{29}/_{9}$-04	$^{27}/_{9}$-04	$^{14}/_{10}$-22	$^{21}/_{9}$-05
1 cm	57	10	1	..	..	..	..
2 -	17	7	28	1	1	..	9
3 -	4	5	39	51	154	156	54
4 -	..	4	2	36	84	90	16
5 -	..	1	..	2	7	18	..
6 -	..	1	..	..	2	6	..
Total	78	28	70	90	248	270	79
Mean length	1.3	2.4	2.6	3.4	3.5	3.5	3.1

It appears from these measurements that at the same time of the year (end of September, beginning of October) the smaller and, consequently, the younger bottom stages are found in deeper water while the bigger-sized, older stages occur in more shallow water. This circumstance may be accounted for in two ways: either by the young dab in their bottom-stage, or even as larvae, being carried to shallower water by the current, or by the facts

[1]) E. Ehrenbaum: Ueber Eier und Jugendformen der Seezunge und anderen im Frühjahre laichenden Fische der Nordsee. Wiss. Meeresunters. N. F. VIII, 2. Abt. Helgoland, 1907.

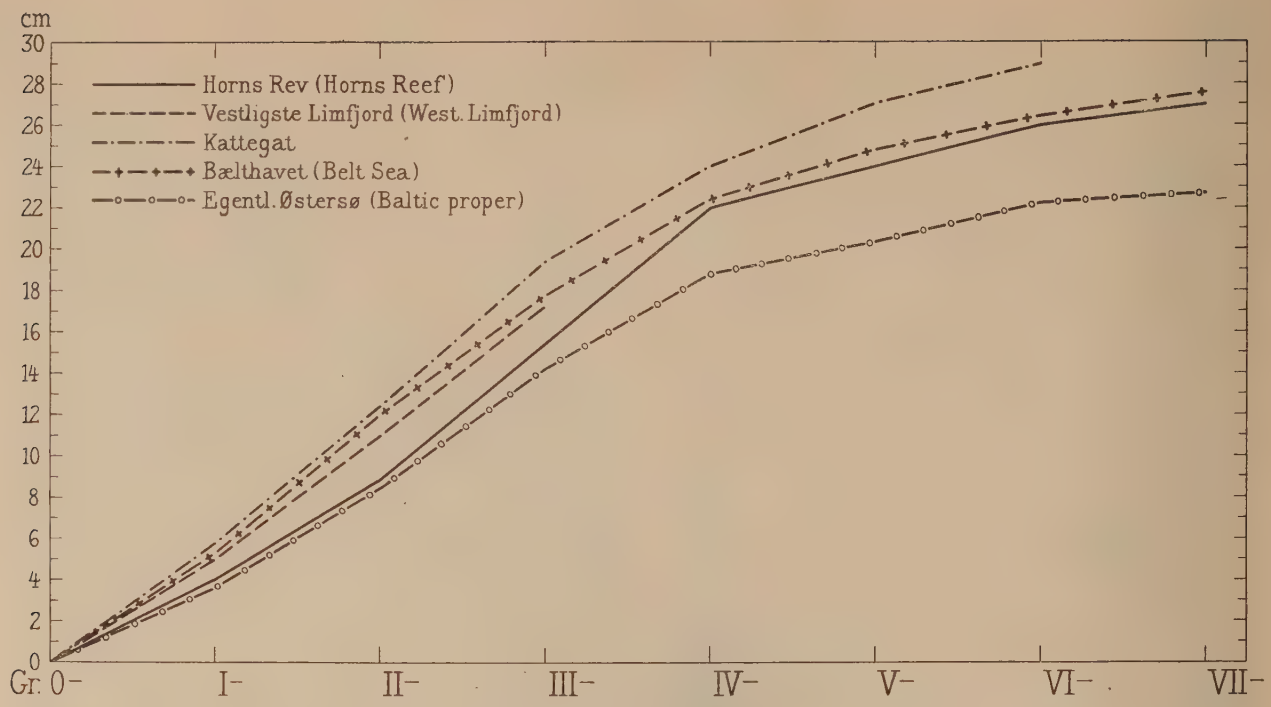

Fig. 3. The growth of the dab through its 7 first years in various Danish waters.

demonstrated by Ehrenbaum[1]), viz., that the dab spawns earlier in the shallow water of the south-eastern North Sea than in the deeper water of the middle and northern parts of this sea; in both cases the young bottom-stages from shallow water are generally older — and consequently larger — than those from deeper water.

According to the measurements given above the young bottom-stages of the 0-Group of dab, caught in the North Sea in the beginning of October, have reached an average length of about 3 cm.

A series of measurings of young bottom-stages caught in the eel-tog in the waters inside the Skaw from the end of August to the beginning of October shows the following average lengths:

Kattegat, September	5.6 cm	(91 ind.)
Northern Belt Sea, Sept.-Oct.	4.7 -	(141 —)
Off Møen, about Aug., 25th	4.7 -	(30 —)

These average lengths are somewhat higher than those which were found in the North Sea, but no doubt this is so because the dab of the inner waters were caught in the eel-tog, which is a somewhat larger-meshed gear.

Throughout the winter the growth is but slow. 371 dab of the I-Group (one year old), which were caught with Petersen's young fish trawl in Graadyb at 9 m. on May 4th, 1907, had an average length of 3.9 cm., they are not much larger than those of an age of about 6 months, caught in the same gear in the autumn.

But already at the end of April some few individuals of the I-Group may be found to be nearly 10 cm. long shown below the measurings of one year old dab caught in trawl with fine-meshed cod-end:

	Kerteminde Bay $^{18}/_{3}$-07	E. of Falster $^{24\text{-}26}/_{3}$-07	Northern Kattegat $^{4\text{-}13}/_{4}$-07	Tannis Bay $^{15}/_{4}$-07	Graa-dyb $^{27}/_{4}$-07
2	2	4	21	25	8
3	24	47	305	53	76
4	42	18	310	20	118
5	8	3	127	27	269
6	2	..	101	26	101
7	..	..	51	20	58
8	..	..	9	6	14
9	..	..	..	1	10
10	..	..	..	..	4
	78	72	924	178	658
Mean length in cm	3.8	3.3	4.2	4.4	5.0

The mean length of the dab at the transition from the 0-Group to the I-Group may be put at about 3 cm. in the Baltic, about 4 cm. in the Belt Sea, and barely 5 cm. in the Kattegat and the North

[1]) E. Ehrenbaum: Eier und Jugendformen der Seezunge und anderen im Frühjahre laichenden Fische der Nordsee. Wiss. Meeresunters. N. F. VIII, Helgoland, 1907.

Sea. The difference, thus, between the various waters is not very great and is easily explained by the fact that the dab of the Belt Sea and the Baltic spawn earlier than that of the Kattegat and the North Sea. Already at this age the dab is much smaller than the plaice, the latter, when one year old, having reached a length of nearly 8 cm., in other words: it is twice as large as the dab.

The growth of the dab through the following years in our different waters is shown in Fig. 3. The graphs were drawn on the basis of the following numbers of dab, the age of which was read by otoliths:

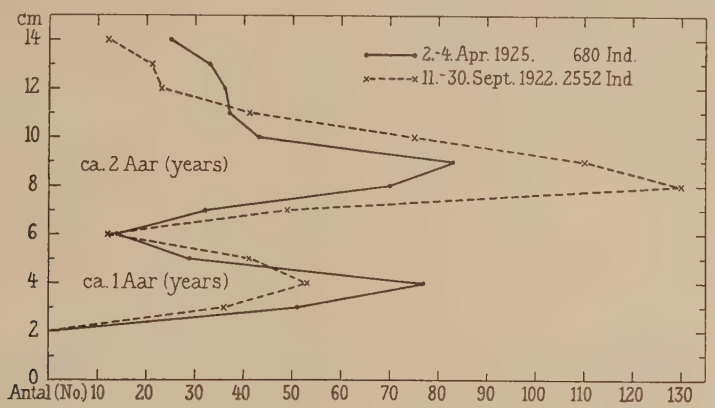

Fig. 4. Measurements of dab (individuals up to and including 14 cm. only) caught in otter-trawl with fine-meshed cod-end in the Horns Reef Area during September and April (the end and the beginning of the growth-period). The lines show the length of the one and two years old dab.

North Sea (Horns Reef) ...	347	(principally older
Western Limfjord	980	than $3\frac{1}{2}$ years)
Kattegat	7 552	
Belt Sea	12 185	
Baltic proper	2 983	
Total...	24 047	

318 individuals of the North Sea dab the age of which was determined, were caught in the commercial fishery and are older fish (of more than 3 years). In order to form an idea of the growth during the first two years or so — beyond the facts already stated — I have in Fig. 4 put down the measures of about 3 000 dab caught by otter-trawl with fine-meshed cod-end in the Horns Reef Area at the end (September) and the beginning (April) of the growth-period. The figure shows two distinct size-groups, which correspond to two consecutive age-groups: one size-group with an average length of about 4 cm., viz. the (0- and the) I-Group (April, 1st), and another, which measures 8—9 cm. and corresponds to the (I- and the) II-Group (April, 1st), in other words: individuals that have lived through one and two periods of growth, respectively. In Fig. 3 the growth of the 0- and I-Groups in the Horns Reef Area is based on these measurings; we have no age-analyses of individuals of the III-Group. The growth of the older age-groups is determined by means of the said samples of dab caught in the Graadyb by fishermen. Consequently, the graph drawn on the basis of these analyses is not representative of the growth in the North Sea at large but only in the Horns Reef Area.

It appears from Fig. 3 that out of the waters investigated the Kattegat shows the greatest rapidity of growth. The three-year-old dab from here average nearly 20 cm.; the dab of 5 years are 27 cm., and those of 6 years are 29 cm. in length.

The growth of the Belt Sea dab is somewhat slower, although not very much. At three years of age the dab of this water has reached an average length of 18 cm., at 5 it is 25 and at 6 it is 26 cm. in length, i. e. 3 cm. shorter than the Kattegat dab at the same age.

A look at Table 2 will show that neither in the Kattegat nor the Belt Sea the population of dab is as dense as in the Horns Reef Area (the North Sea, 1—20 m.). Even in the most thickly populated areas of the two former waters the catch per 30 minutes does not exceed an average of 265 individuals, and for both areas collectively the average is about 117 per hour; in the Horns Reef Area, however, the catches at depths of 1—20 m. average about 500

individuals per hour and for the whole area examined in the North Sea 340 per hour. So there is a much denser population here than in the Kattegat and the Belt Sea. In accordance with this fact the growth of the dab is considerably slower in the Horns Reef Area than in the Kattegat and the Belt Sea: the II-Group of the Horns Reef Area has a mean length of only 9 cm., while that of the two former areas measures a little more than 12 cm. The comparatively slow growth in the Horns Reef Area is undoubtedly due to overpopulation. Thus the dab here live in similar unfavourable conditions of nutrition as the plaice.

In the western Limfjord as well the growth is slower than in the Kattegat. Evidently there is here

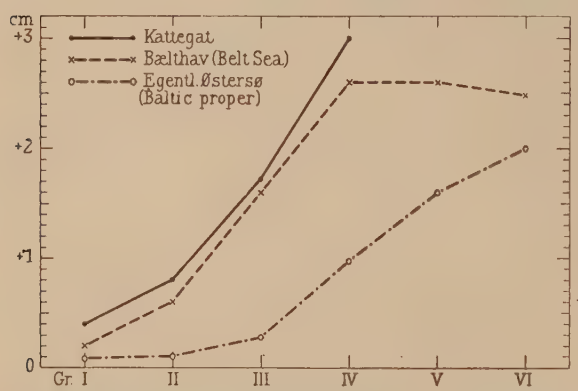

Fig. 5. Difference in growth between males and females; the ciphers on the left of the figure show how much longer the females are than the males.

an overpopulation rather similar to that of the Horns Reef Area. It is a well-known fact that also the plaice population of the westernmost part of the Limfjord is very dense and hence live under bad conditions of nutrition.

However, the slowest growth of the dab is recorded in the Baltic proper. Chr. Hessle (1923)[1]) has called attention to the slower growth of the dab in the area round Bornholm, which is thickly populated, than farther into the Baltic where the population of dab is rather small, and he explains the poor growth of the dab of the Bornholm Deep by overpopulation. In this connexion one should remember the observations made by A. Molander (1926)[2]) that concurrently with the intense fishery within this area in the years between 1919 and 1925 an increase of nearly 4 cm. in the size of the 4- to 6-year-old dab was recorded. Also the Danish investigations (Fig. 3) show a considerably slower growth in the Baltic proper than elsewhere in our waters. The older age-groups are nearly 6 cm. shorter here than the corresponding age-groups of the Kattegat.

Among most kinds of fish, as e. g. the plaice and the cod, there is a difference in respect of growth between the sexes, that of the females being quicker than that of the males. The investigations of the Baltic dab made by Chr. Hessle and A. Molander show a distinct difference of growth in favour of the females. In the following we shall look more closely at this problem and see how it displays itself in the different Danish waters.

Based on a series of age-analyses, comprising 6 655 individuals Fig. 5 shows the difference in growth between males and females of the different age-groups of the dab in the Kattegat, the Belt Sea, and the Baltic proper (the analyses were taken from the material, the age of which had been determined, preferably including such analyses where there is a fairly numerous representation of the somewhat older age-groups). It turns out that in general the females are considerably longer than the males, the difference being smallest in the younger dab. In the Kattegat and the Belt Sea the females of the IV-Group are about 3 cm. longer than the males, but in the Baltic the difference in length is considerably smaller; here it only amounts to 1 cm. From the IV—VI-Group there is no increase in difference as regards the Belt Sea (material from the Kattegat missing), while there is a constant increment of difference in the Baltic dab. That the growth of the females between the ages of 2 and 4 years is considerably quicker than that of the males is evidently due to the fact that the maturity of the former begins nearly a year later than that of the latter (see p. 23), and the period where the females have to use part of the surplus nourishment for the development of the sexual organs thus happens much later than in the case of males. That the difference in growth between males and females continues, in the case of the Baltic dab, for another year than is the case with the Kattegat and the Belt Sea dab, agrees very well with the fact that the maturity of the dab is attained a year later in the Baltic than the two other waters.

[1]) Chr. Hessle: Undersökningar rörande Sandskädden (*Pleuronectes limanda*, L.) i mellersta Östersjön. Medd. Kungl. Lantbruksst. Nr. 243, 1923.

[2]) Arvid R. Molander: Recent Swedish researches into the fish population of the southern Baltic. Svenska hydro. biol. Kom. Ny Serie, Biologi, Bd. I, 2, 1926.

Tab. 7. Age of mature and maturing dab. The numbers tabulated are based upon analyses from January to September; specimens caught as 0-Gr. in Jan.—March and as I-Gr. in April—Sept. are put down as 1 year old etc.

	Nordsøen med Limfjord *North Sea with western Limfjord*				Kattegat				Bælthavet *The Belt Sea*				Østersøen, Ø. f. Møen og Falster *Baltic proper, E. of Møen and Falster*				Østersøen, rundt Bornholm *Baltic proper, round Bornholm*			
	♂		♀		♂		♀		♂		♀		♂		♀		♂		♀	
	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*	Antal Individer undersøgt *No. of specimens investigated*	deraf % konsmodne *thereof % mature*
1 Aar *year*	13	*0*	23	*0*	15	*0*	23	*0*	127	*0*	130	*0*	15	*0*	11	*0*	..	..	..	..
2 —	106	*13*	143	*1*	119	*90*	69	*49*	368	*86*	361	*29*	13	*70*	18	*11*	..	..	..	..
3 —	10	*100*	83	*30*	43	*100*	47	*98*	156	*99*	170	*84*	35	*94*	32	*52*	17	*76*	12	*83*
4 —	1	*100*	51	*88*	2	*100*	12	*100*	59	*100*	51	*100*	13	*100*	11	*91*	70	*64*	106	*32*
5 —	1	*100*	25	*100*	..	..	1	*100*	24	*100*	31	*100*	1	*100*	2	*100*	9	*100*	27	*96*
6 —	..	..	7	*100*	..	..	1	*100*	7	*100*	9	*100*	..	..	2	*100*	2	*100*	7	*100*
7 — + ...	..	..	1	*100*	..	..	..	..	..	..	3	*100*	..	..	..	..	..	..	5	*100*
Ialt...	131		333		179		153		741		755		77		76		98		157	

Age and Length of the Dab upon attaining Sexual Maturity.

For the purpose of determining the age of the dab at first maturity, material has been collected containing maturity- and age-analyses of dab from different waters. The material originates partly from the experimental fishings with the eel-tog and the trawl, partly from the commercial fishery, and it was collected in the period from January to September. Table 7 gives the total of this material. In the class of the one-year-old dab all individuals of the 0-Group caught in January—March were included and all individuals of the I-Group caught in April—September, and so on for the following years.

No mature individuals, neither males nor females, have been met with among the one-year-old dab of our waters. Already among the two-year-old, we find some individuals to be mature, of males 13 per cent. in the North Sea and between 70 and 90 per cent. in the rest of our waters. Everywhere in our waters the bulk of the males (76 to 100 per cent.) among the three-year-old dab are mature; in the North Sea 30 per cent. and in the other waters between 60 and 98 per cent. of the females are mature. Older dab (4 years and more old) showed maturity in all males and nearly all females taken in the North Sea, the Kattegat, and the Belt Sea. In the Baltic, however, many of the females and part of the males among the 4 years old were still immature, while the 5- and 6-year-old dab were practically all mature.

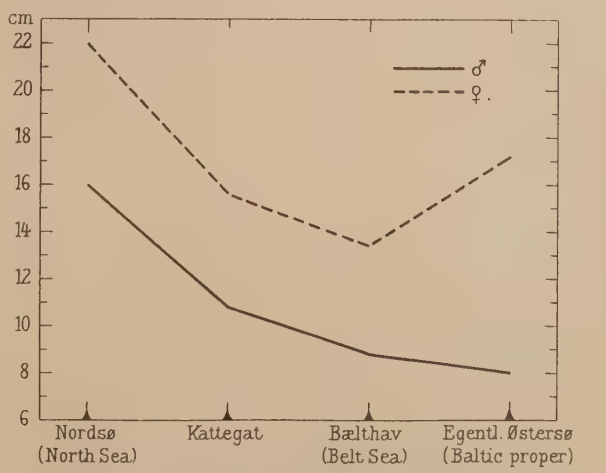

Fig. 6. The size of the dab upon attaining sexual maturity. The contours show the lowest length in cm. at which 50 % are mature.

Thus it is a fact that the males attain maturity nearly one year before the females throughout our waters. Further sexual maturity is attained at a younger age in the Kattegat and the Belt Sea than in the North Sea. The analyses from the Baltic

Tab. 8. Percentage of mature dab at each centimeter length in various Danish waters.

cm	Nordsøen med vestlige Limfjord *The North Sea with the western Limfjord* ♂ Antal Individer undersøgt *No. of specimens investigated*	♂ deraf % kønsmodne *thereof % mature*	♀ Antal Individer undersøgt *No. of specimens investigated*	♀ deraf % kønsmodne *thereof % mature*	The Kattegat ♂ Antal Individer undersøgt *No. of specimens investigated*	♂ deraf % kønsmodne *thereof % mature*	♀ Antal Individer undersøgt *No. of specimens investigated*	♀ deraf % kønsmodne *thereof % mature*	Bælthavet *The Belt Sea* ♂ Antal Individer undersøgt *No. of specimens investigated*	♂ deraf % kønsmodne *thereof % mature*	♀ Antal Individer undersøgt *No. of specimens investigated*	♀ deraf % kønsmodne *thereof % mature*	Egentlige Østersø *The Baltic proper* ♂ Antal Individer undersøgt *No. of specimens investigated*	♂ deraf % kønsmodne *thereof % mature*	♀ Antal Individer undersøgt *No. of specimens investigated*	♀ deraf % kønsmodne *thereof % mature*
5	2	*0*	4	*0*	2	*0*	2	*0*	5	*0*	8	*0*	..	..	..	..
6	7	*0*	15	*0*	3	*0*	3	*0*	23	*0*	24	*0*	..	..	..	..
7	3	*0*	5	*0*	10	*0*	4	*0*	29	*3*	37	*0*	2	*50*	1	*0*
8	..	..	1	*0*	7	*0*	7	*0*	24	*8*	17	*0*	1	*100*	1	*0*
9	1	*0*	3	*0*	12	*0*	6	*0*	26	*54*	16	*25*	4	*75*	4	*0*
10	3	*0*	4	*0*	25	*48*	26	*0*	67	*89*	56	*32*	2	*100*	5	*20*
11	20	*0*	23	*0*	44	*64*	30	*3*	56	*93*	51	*33*	3	*33*	4	*25*
12	21	*5*	27	*0*	35	*74*	37	*14*	49	*98*	31	*39*	0	..	4	*0*
13	20	*5*	24	*0*	54	*83*	38	*32*	32	*88*	39	*33*	4	*100*	5	*0*
14	13	*15*	35	*0*	52	*87*	43	*49*	39	*95*	16	*50*	7	*100*	7	*14*
15	7	*29*	25	*0*	51	*96*	44	*48*	22	*82*	21	*52*	8	*100*	18	*11*
16	4	*50*	16	*7*	46	*96*	34	*71*	19	*100*	8	*75*	11	*100*	19	*6*
17	8	*75*	14	*14*	33	*94*	45	*80*	21	*100*	14	*58*	14	*80*	14	*40*
18	4	*75*	15	*0*	43	*95*	41	*80*	15	*94*	14	*80*	8	*88*	18	*50*
19	1	*100*	15	*0*	41	*100*	47	*96*	11	*100*	14	*89*	6	*100*	8	*63*
20	2	*100*	15	*0*	34	*97*	43	*93*	20	*100*	17	*89*	14	*93*	12	*58*
21	..	..	9	*11*	44	*100*	44	*93*	35	*100*	17	*82*	11	*100*	18	*56*
22	..	..	5	*0*	40	*100*	41	*95*	20	*100*	29	*70*	18	*100*	30	*70*
23	..	..	2	*50*	23	*100*	31	*100*	25	*100*	30	*80*	12	*100*	36	*81*
24	1	*100*	1	*100*	11	*100*	31	*97*	23	*100*	23	*78*	5	*100*	27	*93*
25	..	..	..	..	7	*100*	20	*100*	12	*100*	25	*90*	6	*100*	14	*100*
26	1	*100*	..	..	1	*100*	9	*100*	4	*100*	20	*90*	4	*100*	7	*100*
27	..	..	..	..	2	*100*	9	*100*	4	*100*	18	*100*	3	*100*	7	*86*
28	..	..	..	..	..	..	7	*100*	2	*100*	17	*100*	..	..	4	*100*
29	..	..	..	..	..	..	6	*100*	..	..	8	*100*	..	..	5	*80*
30	..	..	..	..	1	*100*	5	*100*	2	*100*	4	*100*	..	..	1	*100*
31	..	..	..	..	..	..	4	*100*	..	..	4	*100*	..	..	3	*100*
32	..	..	..	..	..	..	1	*100*	..	..	5	*100*	..	..	..	..
33	..	..	..	..	..	..	2	*100*	..	..	5	*100*	..	..	1	*100*
34	..	..	..	..	..	..	..	..	..	..	1	*100*	..	..	..	..
Ialt *Total*	118		258		621		660		585		569		143		273	

seem to indicate that here, again, sexual maturity is attained at a somewhat older age than in the Kattegat and the Belt Sea; but the material from the Baltic being comparatively small and the percentages for the numbers of mature individuals found being a little irregular, a larger material is desirable as far as this water is concerned.

The size of the dab upon attaining sexual maturity is represented in Fig. 6. This figure is based on Table 8, which comprises 3 227 individuals measured and determined as to maturity. The sizes of males and females at which 50 per cent. are mature are given in the figure. It appears from the diagram that the females become mature at a somewhat greater length than the males; the difference is about 5 cm. This is a consequence (1) of the growth of the females being more rapid than that of the males and (2) of the females generally attaining sexual maturity at an older age than the males.

Sexual maturity is attained at somewhat varying

sizes in our different waters, in conformity to the varying age of the dab on attaining sexual maturity. In the North Sea, most of the females do not attain maturity until a length of 22 cm. is reached; the bulk of the males become mature at a length of 16 cm.; in the Kattegat the corresponding figures are lower by about 5 or 6 cm., i. e. 16 and 11 cm. As to the Belt Sea the figures may be put still lower, viz. at 14 and 9 cm. The material from the Baltic is not very large, and thus the results arrived at for this water are possibly somewhat uncertain. The smallest mature individuals were met with in the Belt Sea (and the Baltic), where mature females of only 9 cm. have been caught.

Accordingly there is an obvious difference between plaice and dab as regards size at the time when sexual maturity is attained. While the majority of plaice in the Belt Sea[1]) does not become mature until they are 21—26 cm. long, most dab are mature at lengths of 9—14 cm. Thus the plaice reach maturity simultaneously with reaching marketable value, whereas the dab will mature long before that size. This fact is of interest at the possible introduction of a size limit of the dab, as fixing of such size limit you need not take into consideration the protection of spawning dab, the greater part of them being already protected against the persecution of the fishermen by their small size.

The Occurrence of Dab in the Limfjord.

The dab is found throughout the western and central part of the Limfjord from Thyborøn Kanal to Løgstør Grounds, the quantities, however, varying highly in the different areas; this is illustrated by the following survey of the numbers of dab caught during the fishing experiments of the Danish Biological Station in the years 1927—32:

Area	No. of Stat.	Fishing time in min.	No. of dab caught in eel-tog in the years 1927—32 Total	per 30 min.
Nissum Broad	118	1 604	5 612	*105*
Venø Bay and Kaas and Lavbjerg Broads	64	1 460	1 661	*34*
Sallingsund	22	570	418	*25*
Livø Broad	158	3 657	675	*6*
Thisted and Visby Broads	147	3 601	224	*2*
Risgaarde Broad, Hvalpsund, Skive Fjord, and Louns Broad	65	1 547	43	*0.8*

[1]) A. C. Johansen: l. c. 1912.

These figures show that the density of the stock decreases rapidly from the Nissum Broad inwards: In the Nissum Broad 105 dab were caught per 30 minutes, but the water S. and SE. of Mors yielded 34—25 dab per 30 minutes only, in the Livø Broad the figure per 30 minutes was 6 only, in the Thisted and Visby Broads as low as 2, and in the waters E. of Salling from the Risgaarde Broad down to Louns Broad it dropped to 0.8 even. In other words: The stock of dab in the Limfjord is most dense at the entrance to the Fjord from the North Sea and thinning out eastwards. This distribution goes to show that the dab population of the Limfjord — as is the case with its stock of plaice (C. G. Joh. Petersen, 1897)[1]) — is renewed from outside; from the North Sea. From the following it will be seen that several other facts concerning the biology of the Limfjord dab tend to verify this supposition.

Investigation of maturity and spawning of the Limfjord dab show that but a small minority is mature. During the first half of June, 1931, — i. e. so short after the spawning time, that it was possible to state with absolute certainty which dab had spawned during the past season and which had not — an investigation of the maturity of 356 dab resulted in the following figures:

Stage of maturity	Males		Females		Total	
Immature	86		244		330	
Maturity V (ready to spawn)	7		0		7	
— VI (spawning)	11	22	2	4	13	26
— VII (spent)	4		2		6	
Total...	108		248		356	
Percentage of mature ind....	20 %		2 %		7 %	

For comparison may be mentioned that a sample of 88 dab, also caught in the beginning of June but in the central Kattegat, showed no less than 65 per cent. mature individuals (maturity stages V-VII). According to this investigation a small part only of the dab attains maturity during their stay in the Limfjord, and more especially the number of mature females is so little, that their significance for the preservation of the stock is very small.

It is, therefore, an abvious conclusion that the bulk of the dab found in the Limfjord have immigrated from without. The immigration takes place from the west. The very distribution proves this: There are many dab in the western part and only few in the central part of the Fjord. For if the

[1]) C. G. Joh. Petersen: The Yearly Immigration of Young Plaice into the Limfjord etc. Rep. Dan. Biol. Stat. VI, 1897.

Tab. 9. No. of Dab caught per 30 minutes in t

		April				Maj *May*				Juni *June*			
		Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30′	Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30′	Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30
Nissum Bredning *Nissum Broad*	1927....	9	320	194	18	..	..	..	..	..	..	..	..
	1928....	15	235	76	10	..	..	..	..	14	120	935	234
	1929....	..	..	..	..	..	..	..	..	..	..	..	..
	1930....	..	..	..	..	10	150	372	74	..	..	..	..
	1931....	..	..	..	..	..	..	..	..	7	65	144	66
	1932....	..	..	..	..	7	80	117	44	..	..	..	..
	Ialt *Total*...	24	555	270	15	17	230	489	64	21	185	1079	175
Lavbjerg- og Kaas Br. + Venø Bugt *Lavbjerg and Kaas Br. + Venø bay*	1927....	3	75	16	6	..	..	..	..	..	..	..	..
	1928....	8	360	14	1	..	..	..	..	..	..	..	..
	1929....	..	..	..	..	..	..	..	..	..	..	..	..
	1930....	..	..	..	..	6	165	95	17	..	..	..	..
	1931....	..	..	..	..	..	..	..	..	5	85	142	50
	1932....	..	..	..	..	5	70	58	25	..	..	..	..
	Ialt *Total*...	11	435	30	2	11	235	153	20	5	85	142	50
Sallingsund	1927....	1	60	13	7	..	..	..	..	..	..	..	..
	1928....	3	60	38	19	..	..	..	..	1	30	18	18
	1929....	..	..	..	..	..	..	..	..	..	..	..	..
	1930....	..	..	..	..	2	60	40	20	..	..	..	..
	1931....	..	..	..	..	..	..	..	..	2	30	33	33
	1932....	..	..	..	..	2	30	20	20	..	..	..	..
	Ialt *Total*...	4	120	51	12	4	90	60	20	3	60	51	26
Livø Bredning *Livø Broad*	1927....	8	270	21	2	..	..	..	..	..	..	..	..
	1928....	22	720	8	0.3	..	..	..	..	16	480	229	14
	1929....	..	..	..	..	5	75	32	13	..	..	..	..
	1930....	..	..	..	..	13	390	19	1	..	..	..	..
	1931....	..	..	..	..	..	..	..	..	9	165	36	7
	1932....	..	..	..	..	10	150	17	3	..	..	..	..
	Ialt *Total*...	30	990	29	1	28	615	68	3	25	645	265	12
Thisted-Visby Bredning *Thisted-Visby Broad*	1927....	8	240	33	4	..	..	..	..	..	..	..	..
	1928....	25	780	48..	2	..	..	..	..	13	390	35	3
	1929....	..	..	..	..	..	..	..	..	..	..	..	..
	1930....	..	..	..	..	11	330	2	0.2	..	..	..	..
	1931....	..	..	..	..	..	..	..	..	10	150	16	3
	1932....	10	150	3	0.6	..	..	..	..	..	..	..	..
	Ialt *Total*...	43	1170	84	2	11	330	2	0.2	23	540	51	3
Risgaard-Lovns Br. + Skive Fjord *Risgaard-Lovns Br. + Skive Fjord*	1927....	2	60	1	0.5	..	..	..	..	..	..	..	..
	1928....	12	360	6	0.5	..	..	..	..	..	..	..	..
	1929....	..	..	..	..	..	..	..	..	..	..	..	..
	1930....	..	..	..	..	7	210	3	0.4	..	..	..	..
	1931....	..	..	..	..	..	..	..	..	6	90	3	1
	1932....	..	..	..	..	5	90	2	0.7	..	..	..	..
	Ialt *Total*...	14	429	7	0.5	12	300	5	0.5	6	90	3	1

nfjord in different months in the years 1927—32.

Juli *July*				August				September				April—September			
tal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30′	Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30′	Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30′	Antal Stat. *No. of stat.*	Fisketid *Duration of fishing* Min.	Antal Ising *No. of dab* Total	pr. 30′
5	140	598	128	..	..	..	..	..	..	..	..	24	460	792	52
.	..	..	..	..	..	..	..	14	114	869	229	43	469	1 880	120
.	..	..	..	..	..	..	..	5	70	661	283	5	70	661	283
.	..	..	..	10	150	971	194	..	..	..	..	20	300	1 343	134
.	..	..	..	..	..	..	..	6	65	209	96	13	130	353	81
.	..	..	..	6	95	466	147	..	..	..	..	13	175	583	100
5	140	598	128	16	245	1 437	176	25	249	1 739	209	118	1 604	5 612	105
4	75	21	8	..	..	..	..	..	..	..	..	7	150	37	8
4	105	309	88	..	..	..	..	6	100	417	125	18	565	740	39
.	..	..	..	..	..	..	..	6	110	283	77	6	110	283	77
.	..	..	..	6	150	149	50	..	..	..	..	12	315	344	30
.	..	..	..	..	..	..	..	5	75	29	12	10	160	171	32
.	..	..	..	5	75	17	7	1	15	11	22	11	160	86	16
8	180	330	55	11	225	266	38	18	300	740	74	64	1 460	1 661	34
1	15	9	18	..	..	..	..	..	..	..	..	2	75	22	9
.	..	..	..	..	..	..	..	2	60	124	62	6	150	180	36
.	..	..	..	..	..	..	..	1	30	74	74	1	30	74	74
.	..	..	..	..	..	..	..	2	60	32	16	4	120	72	18
.	..	..	..	..	..	..	..	2	30	14	14	4	60	47	24
.	..	..	..	2	30	0	0	1	15	3	6	5	75	23	9
1	15	9	18	2	30	0	0	8	195	247	38	22	510	418	25
4	405	53	4	..	..	..	..	..	..	..	..	22	675	74	3
.	..	..	..	..	..	..	..	14	420	172	13	52	1 200	409	10
.	..	..	..	..	..	..	..	10	300	42	4	15	375	74	6
.	..	..	..	13	337	6	1	..	..	..	..	26	727	25	1
.	..	..	..	..	..	..	..	10	155	23	4	19	320	59	6
.	..	..	..	8	120	6	2	6	90	1	0.3	24	360	24	4
4	405	53	4	21	457	12	1	40	965	238	7	158	3 657	675	6
3	390	56	4	..	..	..	..	..	..	..	..	21	630	89	4
.	..	..	..	..	..	..	..	13	346	7	0.6	51	1 516	90	2
.	..	..	..	..	..	..	..	12	270	16	2	12	270	16	2
.	..	..	..	..	..	..	..	11	300	3	0.3	22	630	5	0.3
.	..	..	..	..	..	..	..	10	75	5	1	20	225	21	3
.	..	..	..	8	135	0	0	3	45	0	0	21	330	3	0.3
3	390	56	4	8	135	0	0	49	1 036	31	1	147	3 601	224	2
4	120	8	2	..	..	..	..	..	..	..	..	6	180	9	1.5
5	150	10	2	..	..	..	..	6	180	9	2	23	690	25	1
.	..	..	..	..	..	..	..	2	60	0	0	2	60	0	0
.	..	..	..	5	62	0	0	..	..	..	..	12	272	3	0.3
.	..	..	..	..	..	..	..	6	90	1	0.3	12	180	4	0.7
.	..	..	..	5	75	0	0	..	..	..	..	10	165	2	0.4
9	170	18	2	10	137	0	0	14	330	10	1	65	1 547	43	0.8

immigration came from the east, the Livø Broad, where the salinity (about 25 ‰, Aage J. C. Jensen, 1928)[1]) is as high as in the Kattegat off the mouth of the Limfjord and where food abounds (H. Blegvad, 1928)[2]) would be far more thickly populated than is now the case. Finally it should be remembered that the access to the Limfjord is far more easy from the west through the wider Thyborøn Kanal than from the east through the narrow sound between Aalborg and Løgstør Grounds, which is full of islets and grounds. In the following we shall examine this immigration more closely.

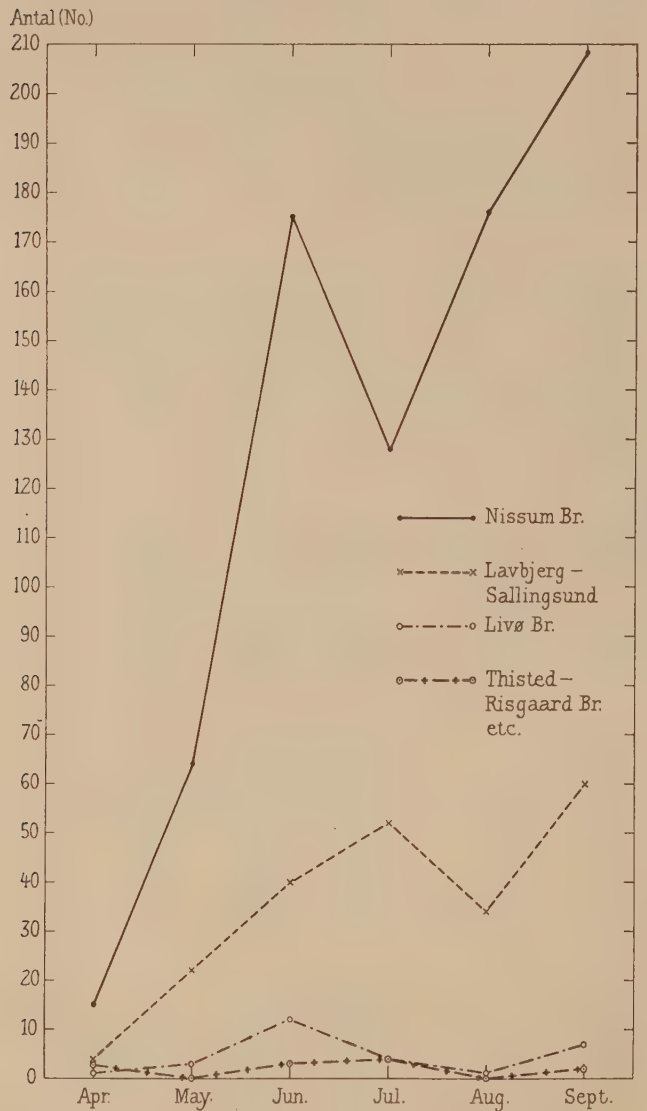

Fig. 7. Average catches of dab with "eel-tog" per 30 minutes in the Limfjord in different months within the period 1927—32.

Table 9 gives a survey of the numbers of dab caught in the eel-tog at different seasons in the various broads of the Limfjord during the years 1927—1932. The graphs of Fig. 7 represent the average catches of dab per 30 minutes in different months within the period April—September (investigations from other seasons not at hand); the calculations were based on the experimental fishings of the years 1927—32. Firstly, the graphs verify the fact already mentioned that the population is densest in the Nissum Broad, less dense in the Lavbjerg Broad, the Venø Bay, the Kaas Broad, and the Sallingsund, and still thinner — or rather very sparse — in the Livø Broad and especially in the Thisted and Visby Broads and the waters E. of Salling. But moreover the graphs show that there is a very rapid increase in the density of the stock from April to September, especially during the months of April, May and June. This state of things appears with special distinctness in the two westernmost areas, the Nissum Broad and the waters S. of Mors. In the Nissum Broad the average catch is 15 individuals per 30 minutes in April, in May 64, in June 175, in July 128, in August 176, and in September it reaches 209 even, i. e. 15 times as many individuals in September as in April. For the waters S. and SE. of Mors (the area from Oddesund to Sallingsund) the corresponding figures are: 2 — 20 — 50 — 55 — 38 — 74, and here, too, the density increases highly during spring and summer. In the other areas individuals are few and the figures consequently rather doubtful, but still a rise is perceptible also in these places. Consequently the comparison of the results of the fishing experiments show that in spring and summer there is a very extensive immigration through the Thyborøn Kanal and further that an immigration may be traced as far as the inmost broads at Thisted and Hvalpsund. But the fishing experiments do not tell us whether part of the dab that enter through the Thyborøn Kanal in spring will reach the inmost areas in the summer of the same year or if the immigration to these places is only due to an inward moving of the population of the intermediate areas; undoubtedly it may be taken for granted that such a movement takes place, but marking experiments have not yet been made to the effect of proving this theory.

[1]) Aage J. C. Jensen: Remarks on the Hydrography of the Limfjord, Rep. Danish Biol. Stat. XXXIV, 1928.

[2]) H. Blegvad: Quantitative Investigations of Bottom Invertebrates in the Limfjord 1910—1927 etc. Rep. Danish Biol. Stat. XXXIV, 1928.

We have seen that the dab immigrates to the Limfjord in spring and early summer chiefly, i. e. at the same time as the plaice, which fish has been proved to enter the Fjord in large numbers in April—July, A. C. Johansen (1928)[1]). There is reason for the belief that this immigration of dab (and plaice) in spring and early summer is dependent on hydrographical conditions. Firstly, it takes place at the very time of the year when the salinity of the western and central parts of the Limfjord is at its highest and when, consequently, the influx through the Thyborøn Kanal is strongest (according to Aage J. C. Jensen, 1928, l. c., the salinity of the surface water at Oddesund is 28 ‰ in March—April, while in July and August it has risen to 30.5 ‰). Secondly, for the years — few as they are (1927—32) — from which extensive annual investigations are at hand, a certain correspondence of the quantity of immigrating dab with the height of salinity may be proved. In the table below the catches per 30 minutes in the Nissum Broad in April—June and July—September of the years 1927—32 are compared with the salinity of the surface water at Oddesund in May—August.

Catch per 30 min. in the Nissum Broad:	1927	1928	1929	1930	1931	1932	Aver.
April—June	18	10	?	74	66	44	42
July—Sept.....	128	230	283	194	96	147	180
Increment in figures	110	220	(221)	120	30	103	138
Mean salinity in May—Aug... ‰	29.8	29.7	30.5	30.1	28.7	30.4	29.9

The figures show that the immigration of 1931 was comparatively small, the said year indicating a rise in number of 30 only against a mean rise in number of 138 for the whole series of years, and the very same year shows the lowest salinity of all six years. The two facts mentioned here tend to establish a connexion between the force of the influx from the west and the quantity of immigrating dab, but investigations for the purpose of corroborating these figures should be extended over a longer series of years.

The dab that immigrate to the Limfjord are mostly small as will appear from the comparison below, which shows the average catches of dab of different size-groups in the periods April—June and July—September, with the increase of number in per cent. during the intermediate time. The calculation of the figures was based on all measurings of dab from the eel-tog fishings in the Nissum Broad in the years 1927—1932:

Nissum Broad 1927—32	Catch in eel-tog per 30 min. April-June	July-Sept.	Increase of quantity in per cent.
3—10 cm.....	31	105	239
11—15 -	19	51	168
16—21 -	5	12	140
21—25 -	0.8	1.5	88
26—30 -	0.05	0	-
No. of individ. measured ..	974	2 496	..

Of dab sized 3 to 10 cm., 31 individuals were caught per 30 minutes in April—June, while in July—September the number had risen to 105, an increase of no less than 239 per cent. In the next size-group, 11 to 15 cm., the rise amounts to 168 per cent., while the two following size-groups, 16 to 20 cm. and 21 to 25 cm. have risen by 140 and 88 per cent., respectively. Broadly speaking the size-groups of 3 to 10 cm. and 11 to 15 cm. correspond to the age-groups I and II. This again means that the bulk of the dab that immigrate to the Limfjord are fully one year old; next come the two-year-old dab, while the immigration of dab that are but a little older is comparatively small.

In September (investigations were not made later in the year) the 0-Group of dab is scarcely 3 cm. long, but on account of its size of mesh the eel-tog cannot catch dab of less than 3 cm., and so the fishings with this gear does not tell us anything of the 0-Group (the fry of the year) and the extent of its immigrations. The immigration of the fry of the year may either take the form of an indrift of pelagic larvae or an immigration (or partly indrift) of the fry that have reached the bottom-stage. As mentioned on p. 19, however, the bottom-stages of the 0-Group do not reach the coastal waters until the autumn, and thus it is out of question that any considerable part of the immigrating dab of the size-group measuring 3 to 10 cm. should consist of bottom-stages of the 0-Group.

The dab that immigrate to the Limfjord do not remain long in this water. It has already been mentioned that but a small part of the dab become mature during their stay in the Limfjord.

In accordance with this fact the population of dab in the Limfjord is principally composed of the youngest year-classes. The table below shows catches of the different age-groups in the eel-tog per 30 minutes; the catches were made in the Limfjord in the years 1927—32:

[1]) A. C. Johansen: The Extent of the Annual Transplantations of Plaice in the Limfjord. Rep. Danish Biol. Stat. XXXIV, 1928.

Year	No. of ind.	Catches in eel-tog per 30 minutes				
		0-Gr.	I-Gr.	II-Gr.	III-Gr.	IV-Gr.
1927	49	..	0.5	3	3	..
1929	284	..	22	58	0.9	..
1930	223	..	47	42	24	..
1931	462	..	6	15	3	0.5
1932	179	6	72	76	22	5
	1 197					

Nearly five sixths of all the dab caught in the Limfjord belong to the age-groups 0—II and nearly one sixth belongs to the age-group III; a few individuals of the IV-Group are found, but older age-groups do not occur in the catches at all. In the Kattegat, however, the eel-tog will take dab of both the V- and the VI-Group, although in small quantities only because this fine-meshed gear is not adapted for the capture of the older age-groups. Dab of the II-Group are very numerous in the Limfjord while dab belonging to the III-Group are far less frequent, and thus we may conclude that large quantities of dab emigrate from the Limfjord during their third year of life. It has been shown that most of our dab become mature towards the end of their third year of life. If we collate this with the fact already mentioned, viz. that mature dab are rare in the Limfjord, it is clear that the dab emigrates from the Limfjord on or before attaining sexual maturity for the first time. To the dab, then — as to the plaice and partly to the cod — the Limfjord is a nursery ground of the young fish, while the adult fish goes elsewhere — into the North Sea — for the purpose of spawning, and from this place the young fish will again immigrate to the Limfjord, mainly in spring and early summer.

Conclusion.

As already mentioned the intensity of the dab fishery shows a constant rise during the last 20 years, and the yield of this fishery has increased from year to year. Thus at present there is every reason to consider the question whether the stock of dab is able to sustain this increasing fishery or not. The observations on the biology of the dab given above show that the dab has a comparatively slow growth: the plaice of our inner waters grows to be marketable (25 cm.) in the course of 2 to 3 years whereas the dab takes 5 or 6 years to attain a similar size. The chances, therefore, of the young dab to grow to marketable size are correspondingly smaller than those of the young plaice, and furthermore, it is greatly hampered by the fact that it is less tenacious than the plaice, so that the young fish of the dab will suffer more during fishing than the plaice. For those reasons it is obvious that a greater number of fry and growing young fish is required for the purpose of procuring a certain quantity of marketable dab than for procuring the same quantity of marketable plaice. In the economy of the sea the marketable dab is, therefore, a more expensive fish than the marketable plaice.

As regards the food the dab is a keen competitor of the plaice. According to calculations based on the investigations of H. Blegvad[1]) the different groups of food animals constituted the following percentages of the stomach contents of dab and plaice:

	Dab	Plaice
Mollusca	37	72
Annelida	21	26
Crustacea	12	2
Others	30	0.1

Consequently the principal food of the plaice is made up of Mollusca and Annelida. More than half the dab food is also constituted by these two groups of animals, and thus the dab becomes a keen competitor of the plaice as regards the food. It appears distincly from this and from the fact that the market value of the dab is considerably lower than that of the plaice that in a water which suite the plaice well and where attempts are made at nursing a considerable stock of plaice it would be unprofitable to try to increase the population of dab as well. Before arrangements are made for the protection of dab in our waters inside the Skaw, it should be considered if it was not more profitable to concentrate the work on effective and extensive efforts to preserve and anlarge the stock of plaice.

At present the stock of dab is not at all threatened by the fishery. The fact that the dab become mature long before it attains a marketable size (s. p. 16) causes that not even an intense dab fishery would be able to diminish the production of young dab perceptibly.

[1]) H. Blegvad: On the Food of Fish in the Danish Waters within The Skaw. Rep. Dan. Biol. Stat. XXIV, 1916.

R. SPÄRCK:

Investigations on the Biology of the Oyster X.

Some preliminary investigations on the power of filtration in *Ostrea edulis*.

We have a great many investigations on the ciliary motion in mollusca, partly on the nature of the motion, partly on the structure of the ciliated organs and the distribution of the cilia, especially on the gills. Among recent works on this subject one should mention the papers published by Orton (1912), Merton (1923), Gray (1923—24), Yonge (1925). Further, in some papers from these late years Galtsoff (1926, 1928a & 1928b) is engaged in the problem of the rate of the ciliary current in the American species of oyster, viz. *Ostrea virginica*. Finally, Viallanes (1892) and Ranson (1926) have dealt with the relative power of filtration in the two European species of oyster, viz. *O. edulis* and *O. angulata*.

A problem which has been touched to a slight degree only, is the vigour of the ciliary motion in the oyster, i. e. its scope of action when no current moves the water. How large a bulk of water is at the disposal of the animal if the surrounding water is nearly completely calm? In fact, this question is of no small importance to the nutrition of the oyster, especially in stationary and limited bodies of water as e. g. the oyster pools of Western Norway or in basins. In order to get some idea of this question I have made some small preliminary experiments. The experiments were carried out in the Zoo-physiological Laboratory of the university, and as in many other cases I am much indebted to Prof. Aug. Krogh, Phil. Dr., the Director of this institution.

For the experiments were used partly some cylindric glass-vessels with a height of 40 cm. and a diameter of 25 cm., partly some larger aquaria with a volume of 30 l. In each of the cylindric glass-vessels was put an oyster, and water was poured over it to a varying height in the different experiments, the water layer over the oyster ranging from 5 to 30 cm. The oysters that were used for the experiments were partly 5-months-old small oysters from the oyster creeks of Western Norway, partly 5-years-old oysters from the Limfjord. The salt water used had a salinity of some 30 $^0/_{00}$, the temperature was 18°—20° C. After the water had stood for some time and had become quiet, another layer of salt water was tenderly poured over the first one through a thin tube; the salinity of this layer of salt water, which had been coloured with methylic blue, had been reduced by about $^1/_{10}$ as compared with the first layer, i. e. it had a salinity of about 27 $^0/_{00}$. Above this layer, finally, was put a layer of fresh water for the purpose of preventing evaporation. Thus the oyster lay in a salt water layer of about 30 $^0/_{00}$, and at a distance of 5—30 cm. — changing for the different experiments — was found another layer of salt water of about 27 $^0/_{00}$, which could easily be distinguished from the layer in which the oyster was found by its blue colour. The upper fresh water layer prevents evaporation and cooling, so that you are allowed to presume that no other currents are found in the two layers of salt water than those produced by the ciliary motions of the oyster. Now the question is whether these ciliary motions are vigorous enough to mix up the two layers. The experiments were extended over 48 hours, and it turned out that the currents produced during this time by the ciliary motions of the oyster were not able to move the water to such a degree, that a mixing occurred. The very slow mixing that took place did not take less time in the vessels where the oysters were found than in the vessels, which — for the purpose of control — did not contain any oysters. During the experiments the animals were often seen to have opened their shells.

Two series of experiments were made with the said glass-vessels, each series comprising 8 experi-

ments with an alternating distance between the oyster and the blue salt water layer above. Further 2 series — each comprising 3 experiments — were made with larger aquaria where in a similar way the water was stratified, so that the oyster was found in the lower uncoloured layer of salt water while a blue salt water layer and a fresh water layer were put above the first one. In these experiments, where larger bodies of water were used, the result was quite the same: the ciliary current was not able to bring about any mixing. So we see that the same results were reached in all 4 series of experiments.

Consequently, even a 5-years-old oyster is not able to mix up two layers of salt water with a difference in salinity of about 3 $^0/_{00}$ with its ciliary current, even though the temperature is as high as between 18°—20° C. which is not very far from the optimal temperature for the ciliary motion in *Mytilus* and *Ostrea virginica* as was shown by Gray and Galtsoff. This can only be read to the effect that in spite of the fact that an oyster is able to send more than 1 l. of water through its gills per hour (in the case of *O. virginica* Galtsoff has even demonstrated about 1.5 l. to pass per hour), this current is not strong enough to cause the said mixing at a distance of 5 cm. This again no doubt means that if the water is completely quiet, the same water will constantly circulate through the gills of the oyster.

Beside the current produced by the cilia the oyster is able to make a sudden motion in the water by suddenly clapping its shells. This motion is of a somewhat farther reach than the ciliary motion. It turned out during the observation of the oyster in the said experiments that by this sudden clapping of the shells a motion was produced in the transitional layer between the two salt water layers. In 5-months-old oysters this motion was perceptible at a distance of 5 cm., in 5-years-old oysters at a distance of 30 cm. But even though it was able to move the transitional layer, the oyster could not by this motion bring about a mixing of the two water layers within a period of 48 hours.

If the water is not completely quiet, i. e. if the upper blue salt water layer is not covered by a fresh water layer, so that currents are produced in the water by the evaporation and changes of temperature, the result of the experiments turns out to be quite different. Two experimental series, each comprising 8 experiments, were carried out in this way. In all cases, even when the distance was 30 cm., a mixing took place in the course of 1—2 hours, and already after about 30 minutes it could easily be seen that the ciliary motion had caused a cone of coloured water to be formed, the point of which was directed towards the oyster. This fact goes to show that when other circumstances bring about a motion and a mixing of the water, the oyster is able to interfere by its ciliary motion and draw the current towards itself, whereas in absolutely quiet water it is only able to move the water in a very small circumference.

The fact that in stagnant water a comparatively small body of water must be supposed to be at the disposal of the oyster, fully explains why in basins, oyster pools, and similar places oyster easily are subject to difficulties as to nourishment causing their death (Spärck, 1926, 1927). In localities where the oyster is to thrive there must either be a pronounced motion of the water or a very intense production of food.

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